Vol. XV, No. 6 JANUARY, 1946

THE TOOL ENGINEER

OFFICIAL PUBLICATION OF THE ASTE AMERICAN SOCIETY OF TOOL ENGINEERS

Going Forever Forward . . . . . *by C. V. Briner*

The Tools and Techniques for the Production of Precision Gears—A Symposium:

Introduction . . . . . *by Andrew E. Rylander*

1. The Evolution of the Gear . . . . . *by Anders Jansson*
2. Gear Shaping—The Fellows System . . . . . *by Edwin W. Miller*
3. Bevel Gear Manufacture—The Gleason System . . . . . *by George Hessler*
4. Gear Shaving and Checking . . . . . *by R. S. Drummond*

The Place of Cooperative Work . . . . . *by Sherman B. Hagberg and Leo. F. Smith*

The Stamping of Electrical Steel . . . . . *by Guy M. Shingledecker*

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Fundamentals of Tool Engineering • Tools of Today • Bulletins • Gadgets • North, East, West, South in Industry • Andygrams • Good Reading • A.S.T.E. News • Index to Advertisers

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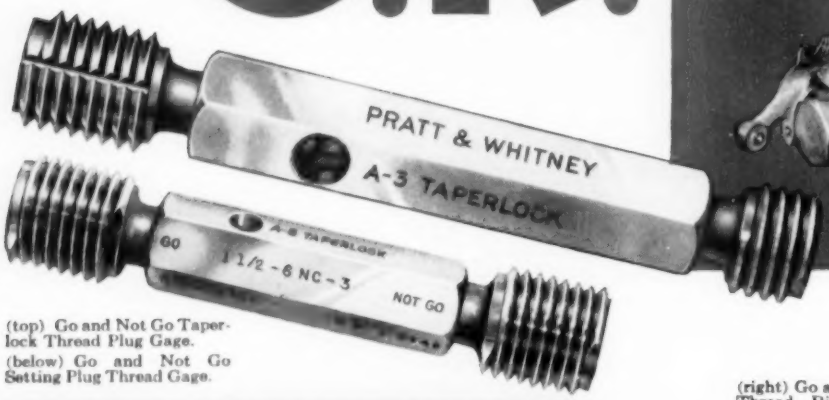
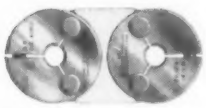


(top) Go and Not Go Taperlock Thread Plug Gage.
(below) Go and Not Go Setting Plug Thread Gage.



(right) Go and Not Go Thread Ring Gages.

(above) Roll Thread Snap Gage in use.

(right) Tri-Roll Thread Gage checking a part, also the setting plug used to set the gage.

(below) Typical Roll Thread Snap Gage.

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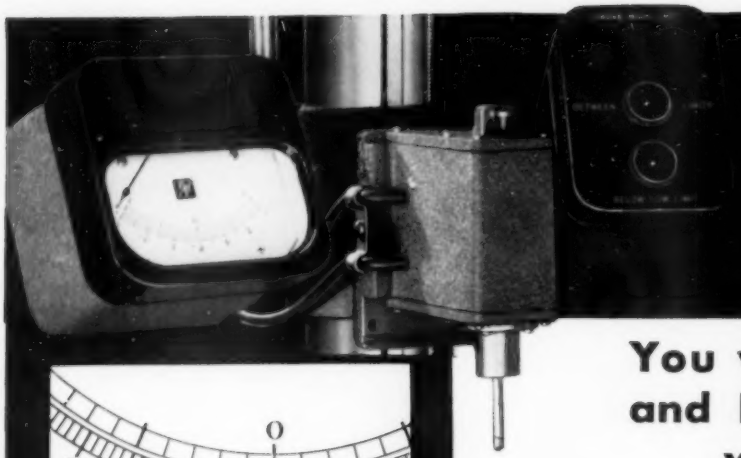

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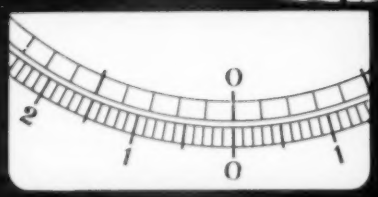

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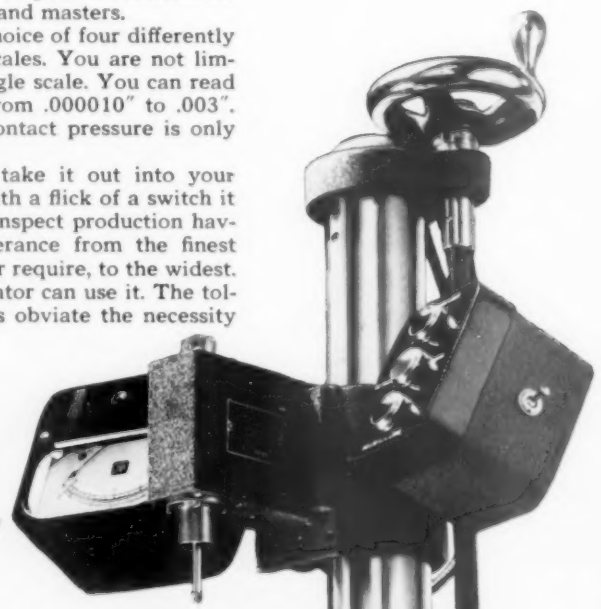

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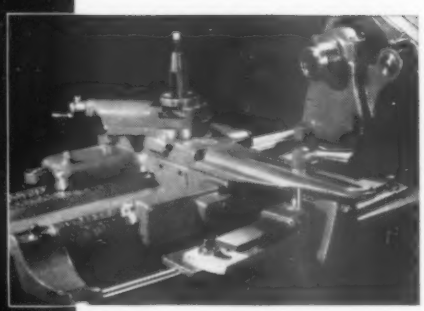

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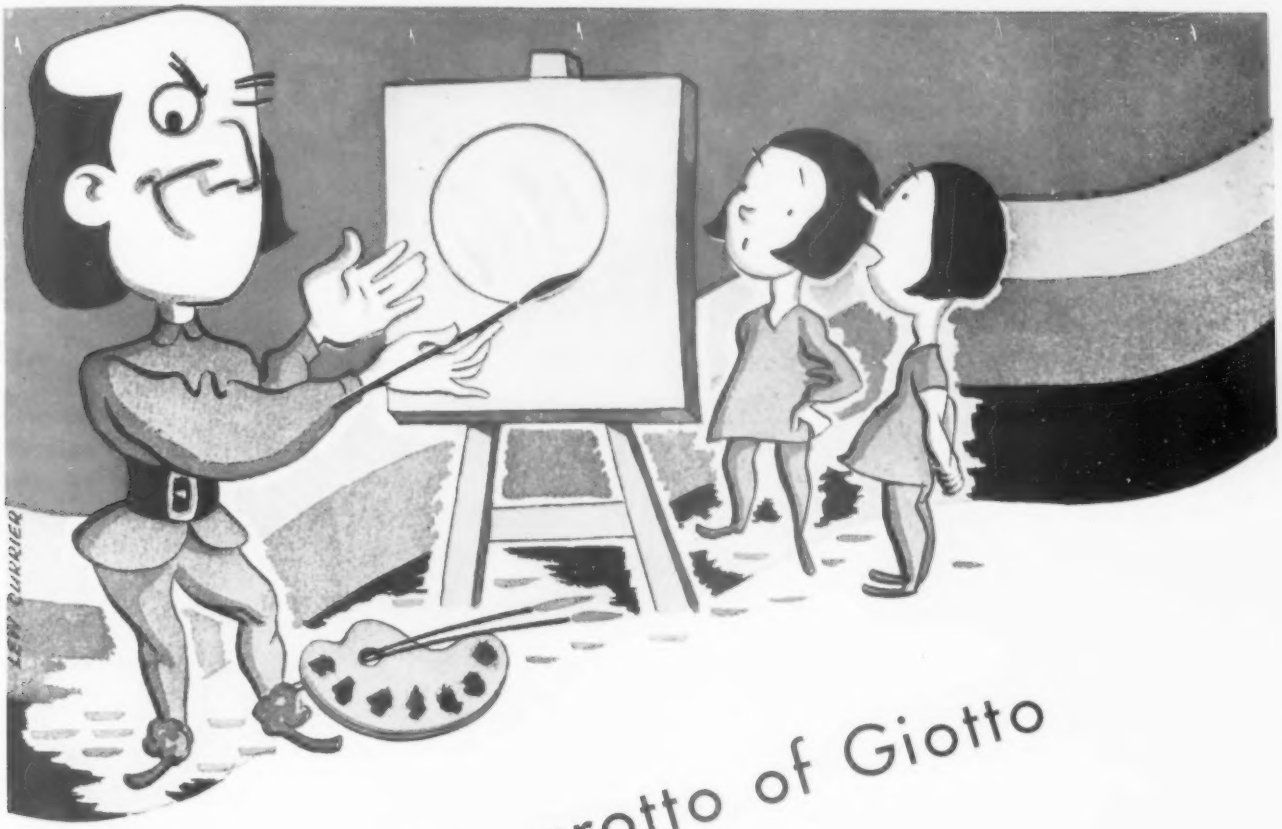

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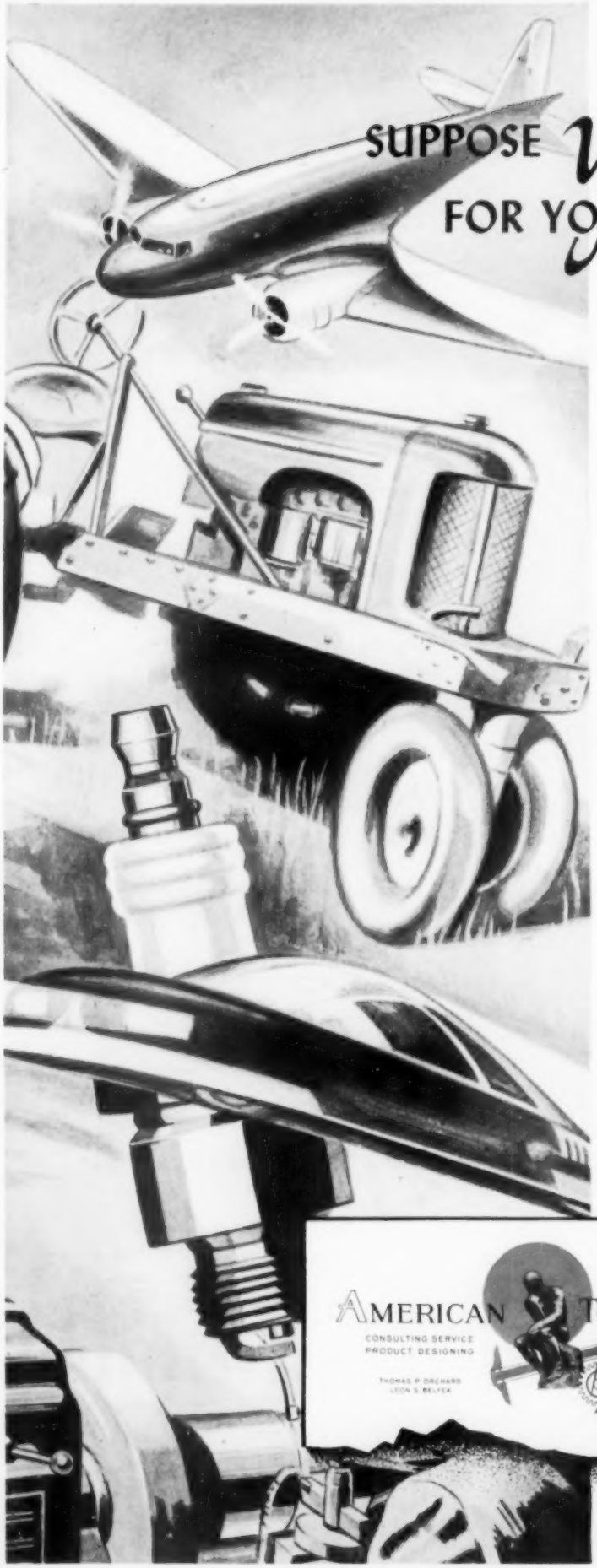

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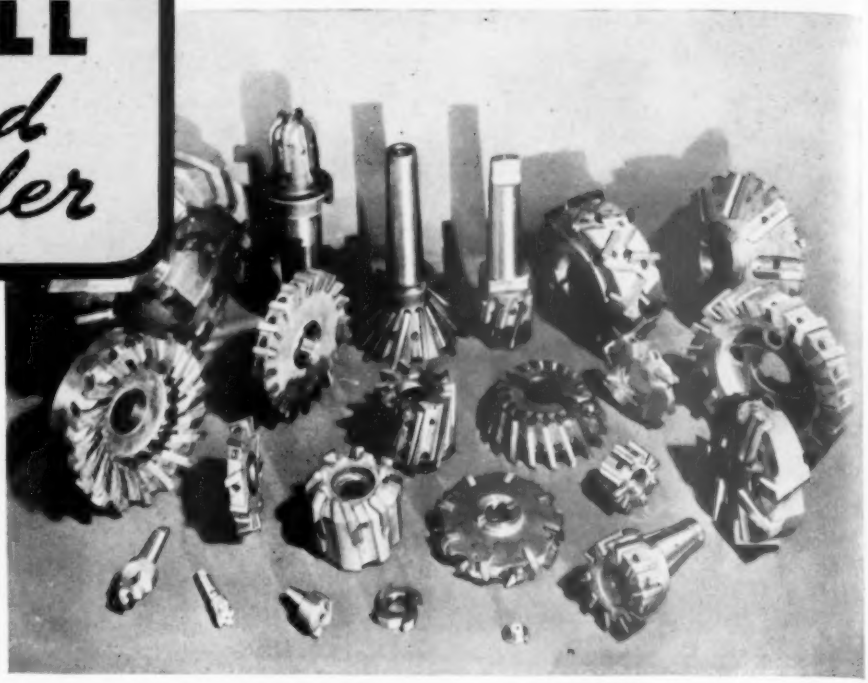

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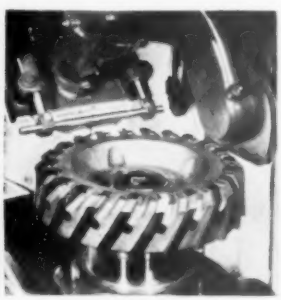

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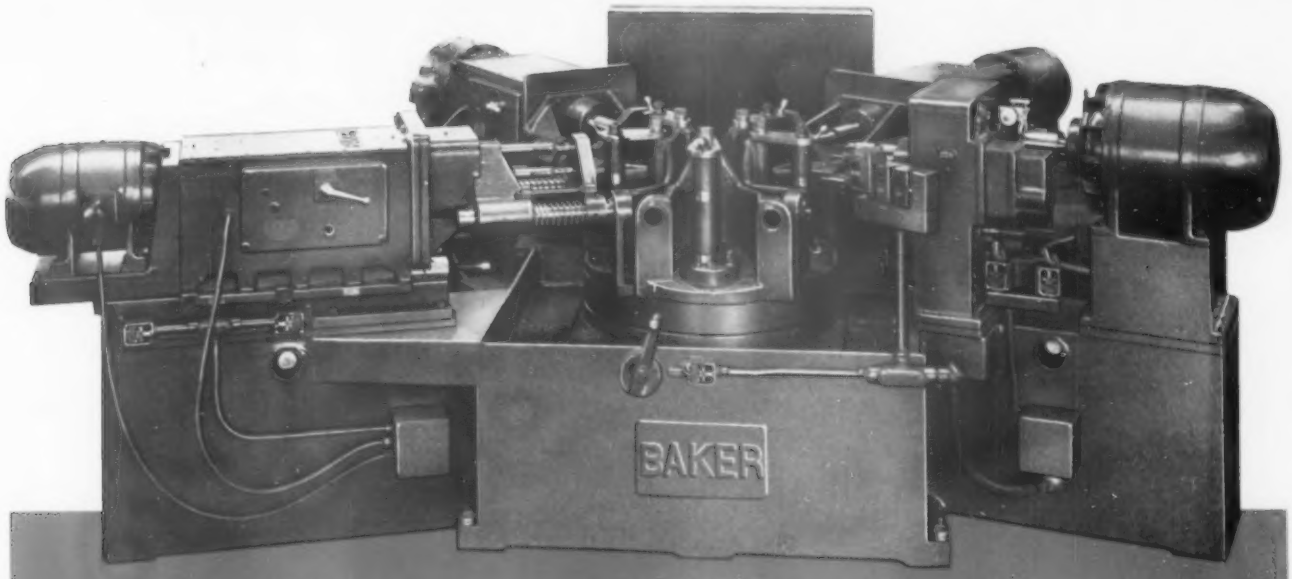

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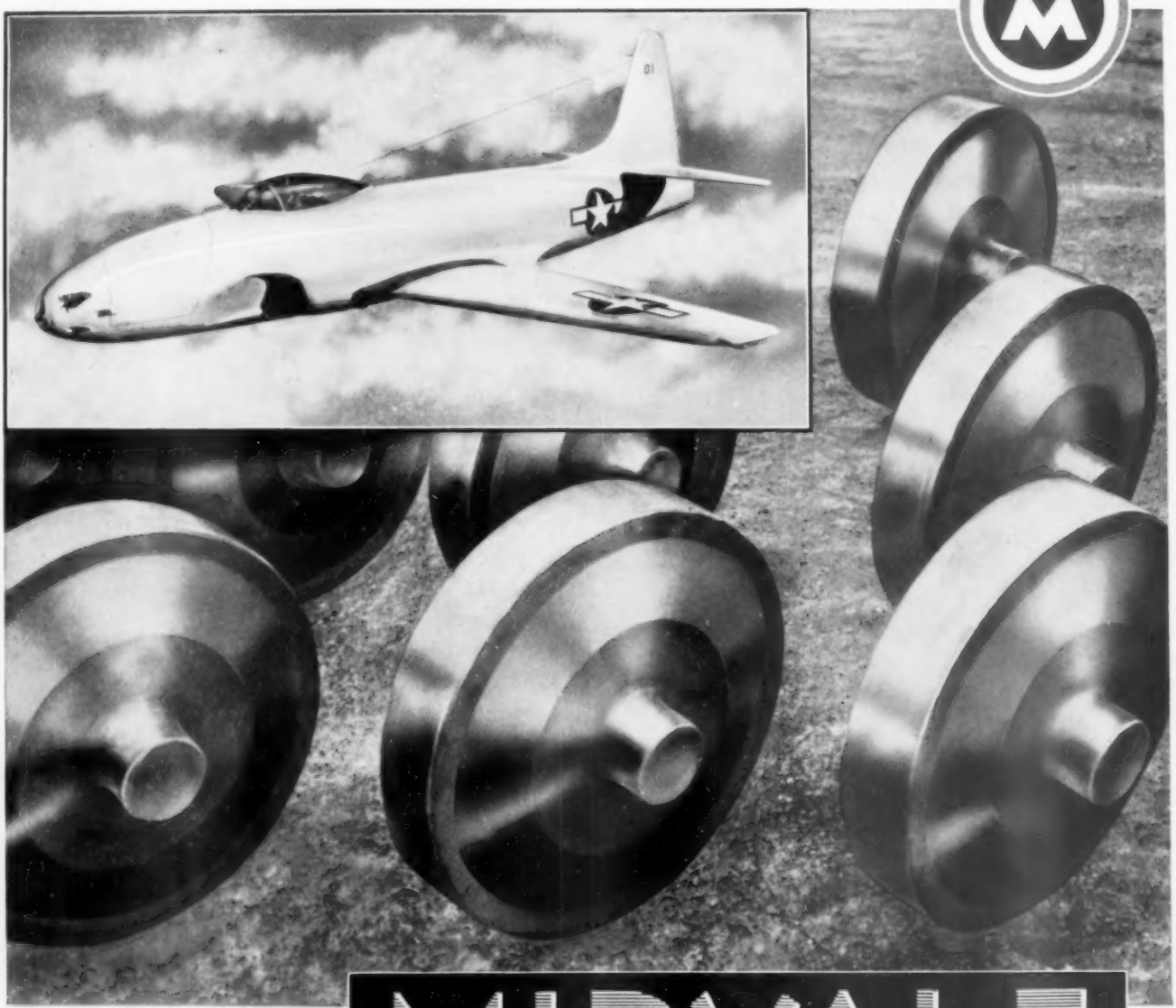

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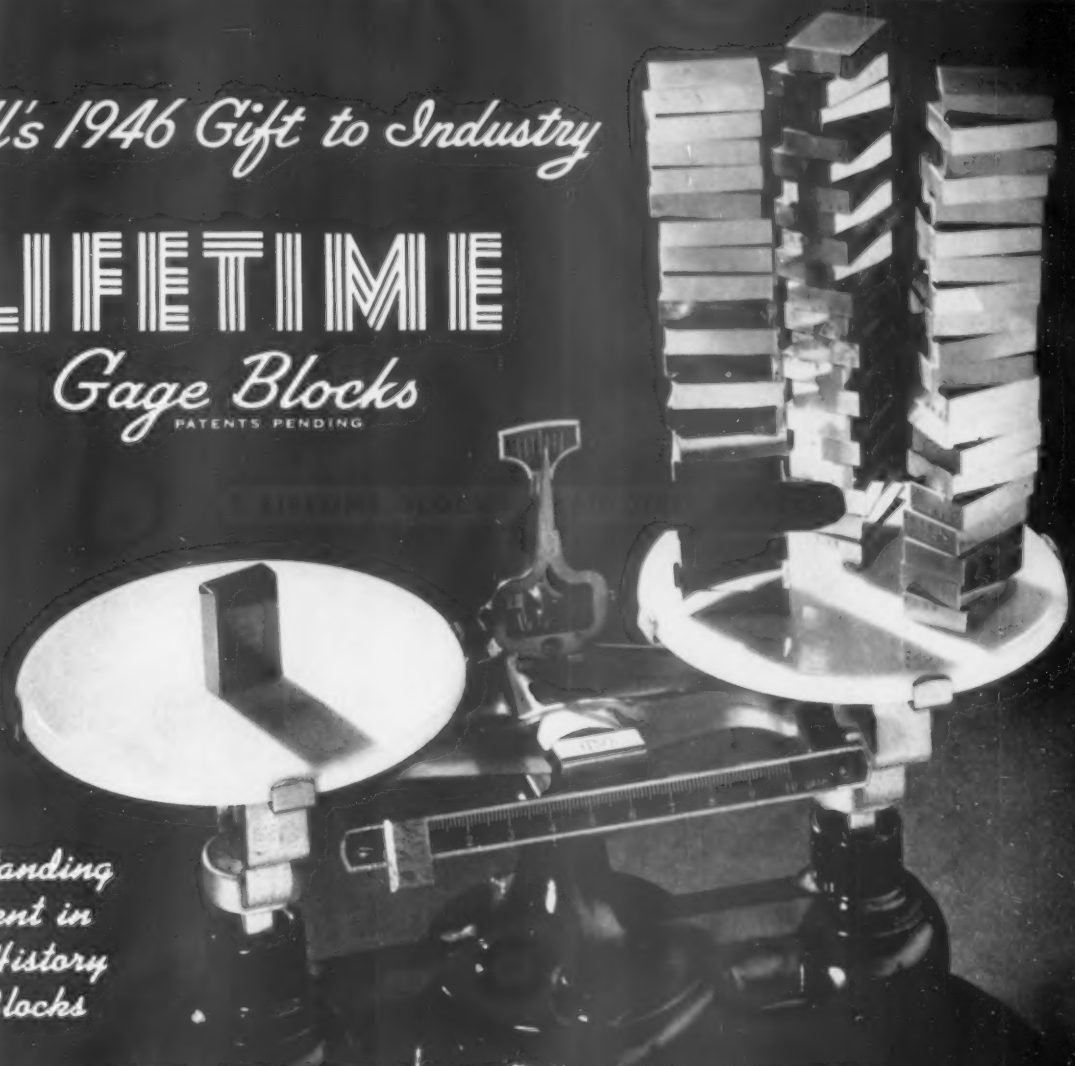

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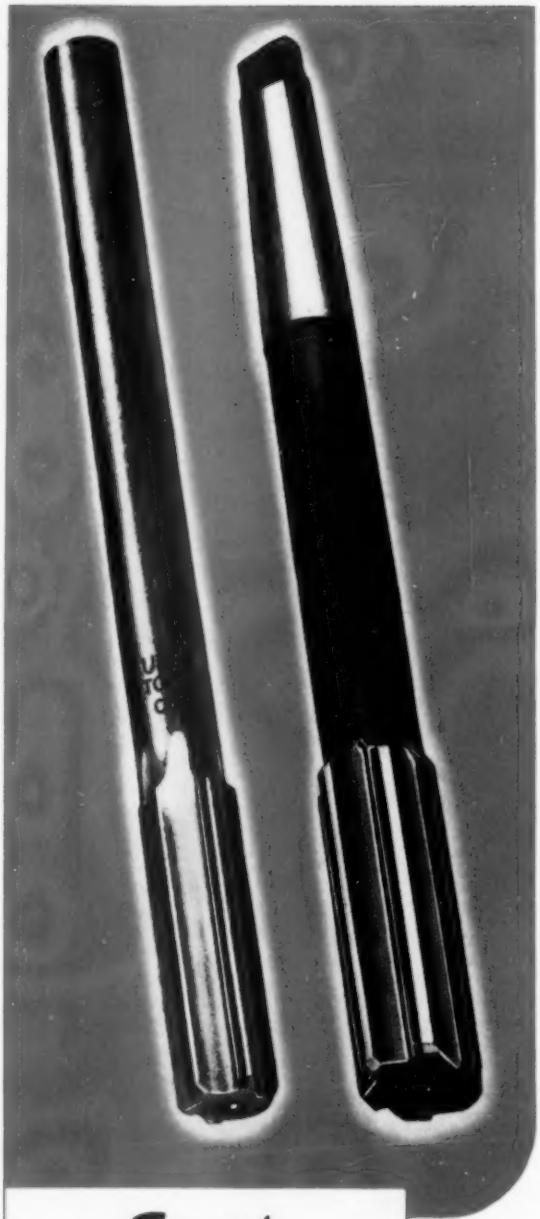

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« Going Forever Forward »

YOU seldom see his name in the headlines. He doesn't sit at the round table of world economic planners. And while he scores his victories every day, the spoils of victory are scarcely ever his. Every triumph on the designing board and in the machine tool plant brings him but another challenge. And more than any other individual in industry, he is responsible for the unceasing upward climb of the American standard of living.

Who else could I be talking about but the tool engineer—the man who is identified right from the start with virtually everything that is manufactured or mass-produced.

In the economic predicament industry finds itself today, the tool engineer becomes an important factor in the necessary corrective processes.

Higher taxes, increased costs of materials, rising food and commodity prices, increased costs of living, higher wages—all of these in the final analysis reach into everyone's pocket. And how conscious we are of that fact in these turbulent postwar days!

No one, regardless of his walk in life, escapes. The farmer, the school teacher, the shop worker, the politician, the executive, the investor, the business and plant owner are all enmeshed in this economic web. The economic stability of a nation depends on the profitable business that is done within and beyond its borders.

The tool engineer, whose name the public seldom sees in print but upon whom so much of the economic life of our country depends, has always been a key factor in the building of any profitable enterprise. Without his peculiar and specialized talents, an idea for a product or machine would still remain just an idea. It is his special role to make the inventor's and the product designer's dream come true and step off in unceasing sequence from the production lines.

Somewhere in the chain of progress of a product from the raw material to the finished product, his ingenuity is inevitably required. His accomplishments in the design and actual building of tools to make the "tools" that lead our armies to victory in World War II are too well known to require comment here.

Victory, though sweet it is, has brought the tool engineer the greatest challenge in his career. The world now needs to be re-tooled for business. Guns, tanks, half-tracks, attack bombers, fighter planes have stepped aside for plows, farm tractors, motor cars, furniture, radios, refrigerators—all of these are now needed in large quantities. They must be mass-produced with special emphasis on quality as well as quantity.

More so than ever before has economy also entered the production picture. If we are to get back our economic balance, it will also be necessary for the tool engineer to make it possible to produce these goods at new low manufacturing costs.

Mass production means products for the masses. Mass production is the key to our future economic prosperity. If we would extend and expand our markets, we must produce more and more at less and less. It is up to the tool engineer to simplify design, to save materials and to eliminate unnecessary manufacturing processes and steps. He has done just this in the past. Without him the motor car, refrigerator and radio would still be a rich man's luxury instead of the modern man's necessity.

The tool engineer, the unsung hero of American industry, seldom achieves the full fruits of his victory. Each triumph of his designing board today calls for a greater triumph for tomorrow. The tool engineer never rests on his laurels.

An "old salt" I knew some years ago, and who refused to retire from his active profession at sea despite his three score and ten, summed up his activity with: "When I rest, I rust." This homey bit of philosophy hits the tool engineer squarely. When the tool engineer rests, he rusts. Going forever forward is fundamental in his profession.

The tool engineer successfully met the challenge of wartime needs with innumerable new machines for destruction. You can be sure he will meet the challenge of the postwar world for peacetime goods and products with equal fortitude and success. He graciously accepts the penalty of leadership.

C. N. Briner

A.S.T.E. President, 1945-46

A Symposium

The Tools and Techniques for the Production of Precision Gears

Accelerating Progress Projects Gear Manufacture into a Fine Art

The Evolution of the Gear

By Anders Jansson

IT HAS BEEN SAID that, without the gear, we could not have arrived at the Machine Age; that—as examples—we would not have the automobile and the airplane, or the automatic cycle machines that, latterly, have played such an important role in mass production. That statement, however, is predicated on the four-cycle engine and therefore, debatable since, without gears, mechanical progress would doubtless have been effected along some other path. We would still have had prime movers.

The electric motor, for instance, is not dependent on gears for its operation, nor is the two-cycle gas engine. We could then (as has been done) driven an automobile by means of belt or friction transmission. And, since the steam engine employs linkage or eccentrics for valve timing, we would still have the locomotive. For that matter, the reaction engine—jet or rocket—that now looms so dramatically on the transportation horizon is equally independent of gears.

As for automatic cycle machines, these can be made to function, in fairly precise synchrony, by means of hydraulic cylinders or motors actuated by cam-operated valves which, in turn, are controlled by electrical "brains." Mechanical progress, then, could have by-passed the gear, seeking some other road to an end. Nevertheless, the gear has shortened the goal by many centuries and has made possible the myriad of machines, appliances and conveniences that we have come to regard as essentials in our machine civilization.

No one knows who invented the gear which, in a crude form—as wooden pins set into the periphery of a wooden wheel—had its genesis in the remote past. Certainly, he antedated the Romans, if not the Egyptians before them. But whoever he was, he should be included among the gods of creation—at least, among those who have achieved immortality through their contributions to human progress.

For the gear has been the fountain head of a flood of invention that, in the past century at least, has assumed torrential proportions. It times the rhythmical pulse of the four-cycle engine, drives the untold millions of automotive vehicles which it powers and controls traffic on countless miles of highways and city streets. It is incorporated in agricultural and dairy equipment, in practically all machine tools and in the machinery used for the processing of food, clothing, shelter and fuel.

It is a component of the typewriter on which this copy is written, and of the printing presses and the business machines which have come to be integral parts in our design of civilization. On it, countless industries have been founded, and these in turn employ their untold legions of workers. It has made man the master of time itself, and has enabled him to synchronize the modern world and to foretell, with mathematical precision, the transit of heavenly bodies in the universe.

The gear has created its own unique school of mathematics, and its progressive refinement has, in turn, necessitated an ultra-refinement of the tools and methods employed for its manufacture. It has been a powerful force for change, yet, its role has been evolutionary rather than revo-

In presenting this Symposium to our readers, we have purposely steered away from academic theory and involved mathematics. For, essential as these are to the science of gearing, they are nevertheless "tools" for the specialists—the *career men* in gearing—and may be had in standard text and reference books. Besides, such complete coverage would imply a work that, to say the least, would be encyclopedic in its ramifications, and such is not the purpose.

Rather, the purpose is to give a majority of readers a comprehensive insight into the techniques and tools employed in modern gear manufacture while, at the same time, showing cause for their development. To that end, the various articles are couched in simple terms, the whole with a view toward extending the "know-how" of mass production.

We have drawn from a wide and diversified field that includes machine tools, testing equipment, product manufacture, heat treating, finishing and, what is particularly important, *experience*. From the evolution of the gear through to the final stages of processing, the articles are authoritative and, in several instances, written by men who have devoted a half century, more or less, to the development of gears and the equipment used for their manufacture. These men have made remarkable contributions to the science of gearing.

Because of its scope, this Symposium will be divided into two or more installments. In this—the first—we will deal mainly with the methods and tools employed in gear cutting, reserving finishing operations for later consideration. There may be some overlapping, if not close duplication; where such occurs, however, it will be found that the several authors have approached similar problems from different but converging paths. This is especially true of gear finishing which, latterly, has been refined to a high art.

Several of the articles are staff written from material contributed by known authorities. In this connection, we gratefully acknowledge the fine cooperation of Mr. B. P. Graves, director of design, the Brown & Sharpe Manufacturing Company, and of his associates, Messrs. Harold Sizer and B. F. Waterman. To these men, we are especially indebted for photographs that, bearing on the evolution of gearing are of considerable historical interest.

We have drawn widely from notes and papers by Mr. Waterman who, connected with the Brown & Sharpe Gear Div'n at the turn of the century, was superintendent of the Division for a number of years. One of the pioneers in the gear industry in America, he has made outstanding contributions to its development. He is author of many excellent articles on gear processing and a past president of the American Gear Manufacturers' Ass'n, in which he has been an active force. He has also presented papers, at A.S.T.E. Chapter meetings, which have aroused a wide interest.

We are also indebted to Mr. George Sanborn, field engineer with the Fellows Gear Shaper Company, for invaluable assistance in the preparation of this Symposium, and to Mr. E. C. Shultz, advertising manager of the Pratt & Whitney Div'n, Niles-Bement-Pond Company, for material in connection with gear grinding. This will appear in a later installment, along with gear finishing. To these men and to all who have directly contributed articles and who will be introduced in the order as they appear, our sincere thanks for interesting and instructive papers on the Art of Gear Processing.

Andrew E. Rylander

Technical Editor.

lutionary. From a crude beginning, its course throughout history has been one of slow but, latterly, accelerating progress.

Up to the middle ages, the gear had been employed mainly to drive primitive implements. Then, in the 13th century, it came into use for driving clock movements. However, the gears employed were mainly of wood, laboriously hand cut, and it wasn't until the latter part of the 18th century that metal gears were used, and then mainly in the "turnip" pocket timepieces of the period. The first all metal clock is said to have been produced in the United States—in New Haven, to be exact—around 1837.

Supporting the old saw that "there's nothing new under the sun," however, a gear developed by Dr. Hooke in 1666 (he called it "the perfection of wheel work") is at once the prototype of the modern helical gear and the laminated gear. It was made up of a number of spur plates stepped in even increments and bonded together. It is shown in Fig. 1, in prototype of the modern helical gear and the laminated gear. combination with a helical pinion.

In 1733, a Frenchman by name of Camus discovered and proposed the epicycloid as the basis for gear teeth, and these gears were used well into the 20th century. However, they had definite limitations since, for one thing, they precluded variable center distances and, for another, the shape of the teeth at the pitch line was nearly parallel. Because of this, cutters had to be made with side clearance and became progressively thinner with each sharpening, thereby changing the relative widths of teeth and spaces on the pitch line.

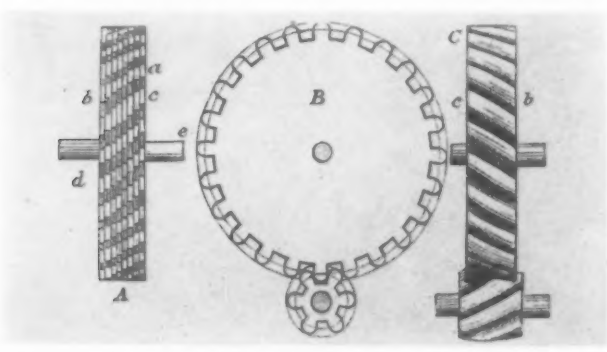
The involute form—or its progenitor—is said to have been discovered by a Russian, Euler, about 1760, who wrote extensively on the subject and who, further, investigated a general expression for circular arcs that embodies the property of revolving contact with constant velocity ratio. At the time, the involute was objected to on the ground that it created excessive pressure on the centers—a contention later proven fallacious.

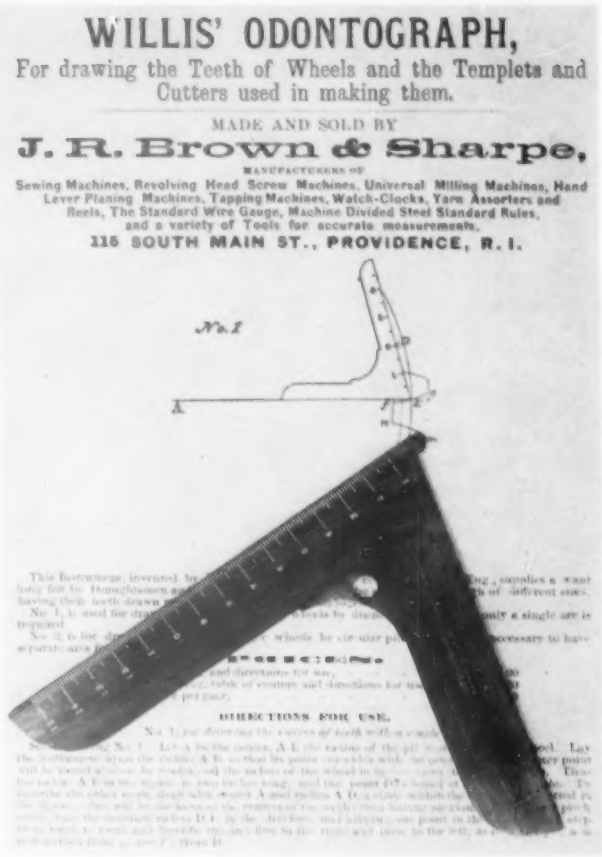
Willis, in 1838, elaborated on the methods suggested by Euler and invented the Odontograph, an instrument that to all practical purposes, dispensed with mathematical calculations. The instrument had two arms, making an angle of 75° with each other and thereby establishing the 15° pressure angle which, until comparatively recent times, was the accepted standard. The edge of one arm corresponded to the radius, the other to the line of action.

The latter edge was divided into a scale of equal parts numbered both ways from the intersection of the two edges —that is, it had two scales, one being the scale of centers for faces, the other for flanks. Two Odontographs were manufactured and sold by the Brown & Sharpe Mfg. Com-

All photographs, shown in connection with this article, are reproduced through the courtesy of the Brown & Sharpe Mfg. Co., Providence, R. I.

FIG. 1. The Hooke gear, invented ca. 1666, is the prototype of the modern helical gear.




WILLIS' ODONTOGRAPH,
For drawing the Teeth of Wheels and the Templets and Cutters used in making them.
MADE AND SOLD BY
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MANUFACTURERS OF
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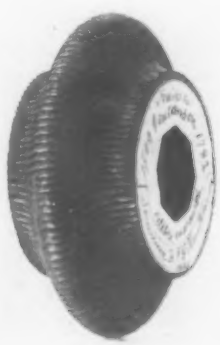
No. 1
DIRECTIONS FOR USE.

FIG. 2. The Odontograph, invented by Willis and subsequently manufactured by the Brown & Sharpe Mfg. Co.

pany, and were illustrated in the B & S catalogues as late as 1891. The larger, roughly described above, was used for drawing double curve teeth, while the smaller—illustrated in Fig. 2—was for single curve gears.

As early as 1782 the French mechanician, Vaucouson, made a rotary gear cutter having many fine teeth and an octagonal hole. This is shown in Fig. 3. In effect, it is a rotary file, yet, an excellent piece of workmanship considering the times. Now, if rotary gear cutters were made as early as the middle 18th century, the logical corollary is that there were also gear cutting machines on which they could be used. Such a machine, however, need not have been particularly elaborate; perhaps a spindle provided with limited feed movement and the gear—wood or metal—marked off with dividers and indexed to a pointer and then clamped during the cut.



By 1841, however, a gear cutting machine of considerable versatility had been developed by Gaskell, of Manchester, England. This machine, which is shown in Fig. 4, was used for cutting the teeth in wooden models—presumably patterns for the molding of cast iron gears. A flycutter was used, mounted on a vertical spindle having crosswise feed and driven by a round belt. The gear—or model—was mounted

FIG. 3. The Vaucouson rotary gear cutter, invented in 1782.

on a horizontal spindle. Index was by worm and change gears, and the swiveling cutter head indicates that bevel as well as spur gears could be cut.

It appears that, up to and about the middle of the 19th century, no equipment adequate for the machine cutting of metal gears had been developed. This statement, however, is advanced with certain reservations. For, while authentic records are not available at time of writing, there comes to mind that Sir Joshua Whitworth employed cut change gears, for machine tools of his design, somewhere around 1850. And, in view of the high refinement of his machines, he probably did. Up to then, however, gears were mainly cast and accuracy was only relative with mating gears loosely matched to compensate for run-out and unequal tooth spacing.

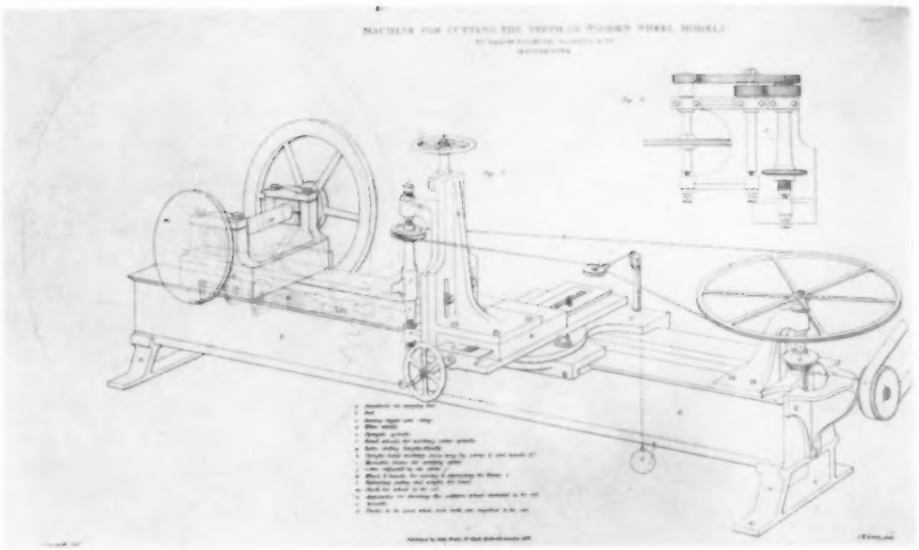


FIG. 4. The Gaskell gear cutting machine, produced in Manchester, England, about 1841.

At the time then several problems faced the producers of gears, as:

(1) to accurately index a gear blank so that tooth spacing would be accurate—say within .001"—and,

(2) to cut and accurately reproduce an exact tooth form or profile.

These two problems, at least, were solved by Joseph R. Brown, inventor and partner in the Brown & Sharpe Mfg. Co., Providence, R. I.

In 1855, a "Geer-Cutting Engine," invented by Brown, was announced by the company, which then proceeded to solicit work in gear cutting and indexing. The machine, which is shown in Fig. 5, was hand operated but, as may be judged by the illustration, was by way of being "universal" and capable of cutting bevel as well as spur gears—and, no doubt, worm wheels as well. However, it was not reproduced, being used entirely in the Brown & Sharpe plant to produce gears and index plates to customers' specifications. It may be of interest, here, that its first and only operator—one Pat Harlow—ran it for some fifty years, or well into the twentieth century.

About twenty years later, an automatic gear cutter was designed at Brown & Sharpe's and, after exhaustive tests, was offered to industry as a standard machine in their

FIG. 5. The "Geer-Cutting Engine," invented by Joseph R. Brown in 1855. This was the first precision gear cutting machine.

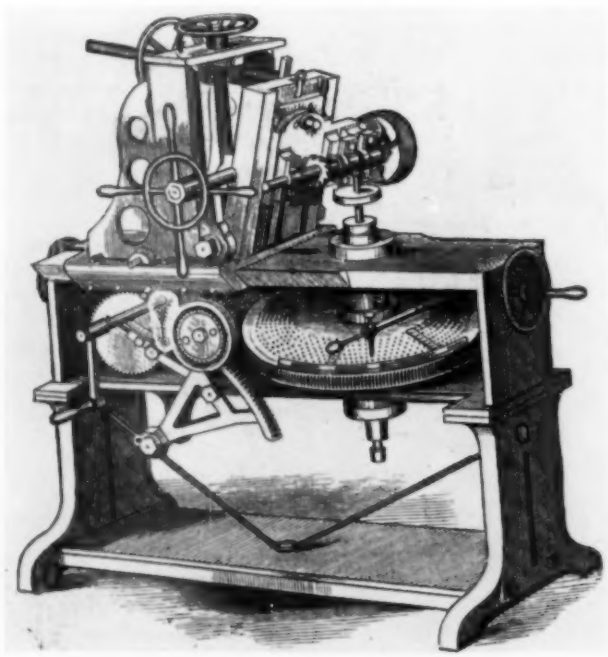
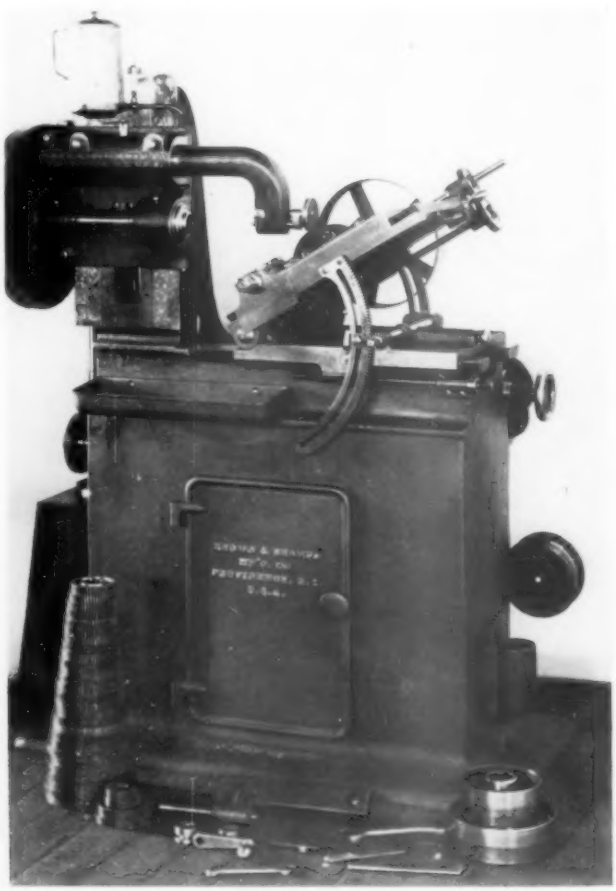


FIG. 6. The first automatic gear cutting machine, for spurs and bevels, manufactured in America. A Brown & Sharpe machine introduced in the company's catalog of 1880.



catalog of 1880. Shown in Fig. 6, this machine employed a large diameter worm wheel, mounted directly on the work spindle, to insure accurate index—a feature characteristic of most gear cutting and hobbing machines built since that time. The machine was "universal," cutting both spur and bevel gears, and was fully automatic. A later type of Brown & Sharpe automatic gear cutting machine, highly refined, is shown in Fig. 7.

One of the truly important contributions to the art of gear cutting was the involute cutter, invented by Joseph Brown in 1864 and shown in Fig. 8. As far as is known, this was the first backed-off gear cutter, and permitted recurrent sharpening without changing the form. Of particular interest, in view of its bearing on later developments, is that while the design of this cutter was based on the theories advanced by Willis and Sang, the Brown & Sharpe formed cutter was based on the true involute, not on the Odontograph.

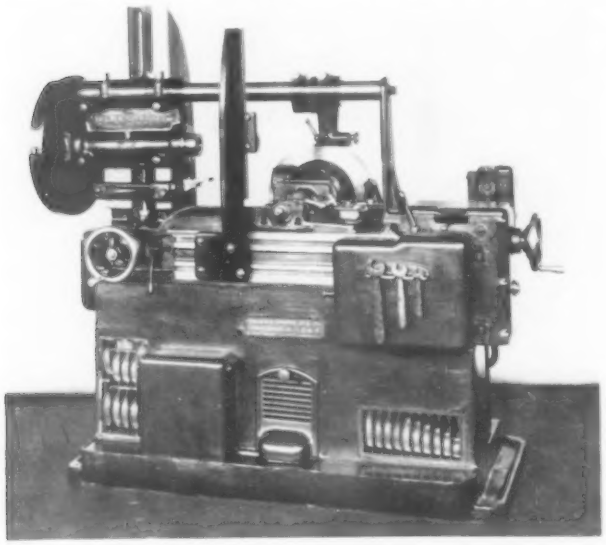
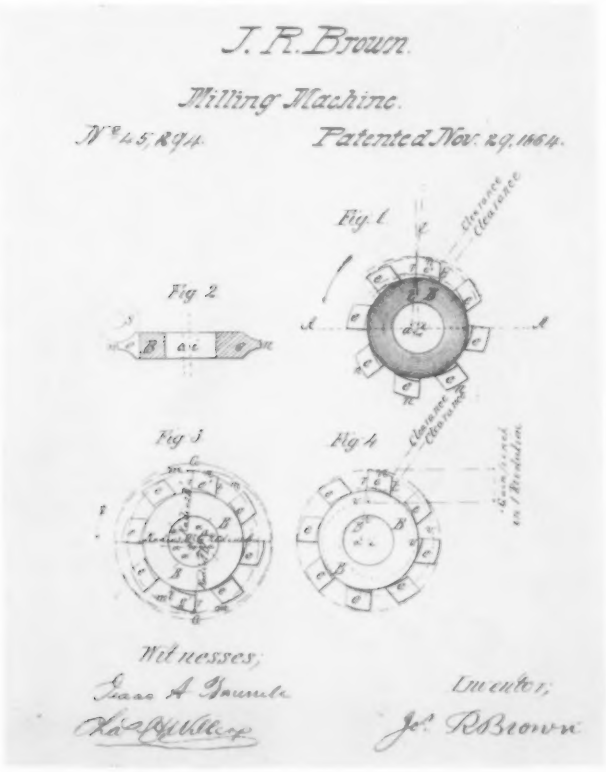


FIG. 7. A modern Brown & Sharpe automatic gear cutting machine, for spurs. While manufacture has been discontinued, these machines are still widely used.

FIG. 8. The original backed-off gear cutter, patented by Joseph R. Brown in 1864. This cutter could be sharpened without changing tooth form.



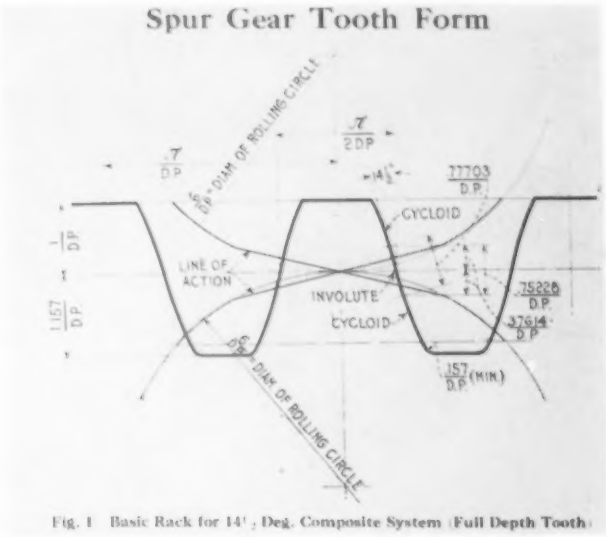


Fig. 1 Basic Rack for 14½ Deg. Composite System (Full Depth Tooth)

FIG. 9. Spur gear tooth form, as developed by Brown and Sharpe's.

The base of the B&S system was the 12-tooth gear with a radial flank below the base circle. This radial flank was an internal cycloid with a rolling circle equal to the pitch circle radius, with the face of the engaging tooth an epicycloidal extension to clear the radial flank. See Fig. 9.

Shortly after the introduction of the first backed-off cutter —or in 1867—the Brown & Sharpe line of formed gear cutters was announced. (See Fig. 10 for a typical, modern B & S cutter.) A page from a contemporary catalog is shown in Fig. 11. These cutters were based on the 14½° involute curve and, for any given pitch, a series of eight cutters covered the entire range of gears from 12 teeth to a rack. Any gear, cut with these cutters, would operate with any other gear of the same pitch.

In connection with gear manufacture, Brown & Sharpe's also developed various measuring tools and gages, as the vernier caliper for measuring bottom diameters, shown in Fig. 12, and the vernier gear tooth caliper for measuring, shown in Fig. 13. They also manufactured a micrometer scratch gage, for marking the tooth depth on bevel gear blanks, Fig. 14, and various other tools, gages and instruments used in the manufacture of gears.

During these years—that is, from about 1855 to the turn of the century—the merits of the involute and cycloidal curves was sharply contested, and Brown & Sharpe's actually offered cycloidal cutters made with backed-off and unchanging form. But, twenty-four cutters were necessary to cut the same range covered with the eight involute cutters,

FIG. 10. A modern rotary spur gear cutter. Bevel gear cutters are similar, except that they are thinner.

and the cycloidal cutters were gradually obsoleted in favor of the involute.

While the Brown & Sharpe Manufacturing Company pioneered the art of gear cutting in the United States, and made invaluable contributions in machines, tools and methods, there were inherent faults in the system of rotary cutting. And, the company was among the first to concede these faults. For one thing, it was not possible to cut a bevel gear and, at the same time, to maintain a uniform tooth form.

PATENT CUTTERS.

TEETH OF GEAR WHEELS.

WHICH CAN BE SHARPENED BY GRINDING

WITHOUT CHANGING THEIR FORM.

MANUFACTURED BY

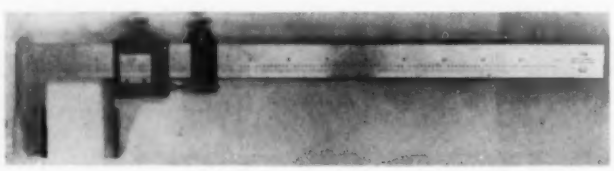
J. R. BROWN & SHARPE,

PROVIDENCE, R. I.

FIG. 11. Reproduction of page from early Brown & Sharpe catalog, describing the rotary gear cutters.

For example, the form would be correct at the O.D., but the pitch line would raise as the cuts converged; besides, it was necessary to make two cuts, each with the cutter off center, to obtain an approximately correct tooth. To make corrections, then, it was necessary to "spot" mating bevels by running them together and then to file the teeth until the gears ran smoothly. This again, led to a new development—the generating of gear teeth by means of serrated or "mutilated" cutters, shown in Figs. 15 and 16.

FIG. 12. Vernier caliper, for measuring bottom diameters of gears.



Again bearing out the old saw that "there's nothing new under the sun," these gear tooth generators—invented by Oscar J. Beale and patented in 1898—and the machines in which they were used (Figs. 17 and 18) were the forerunners of modern gear shaving equipment. For, while the latter has been considerably refined, the general principle is substantially the same.

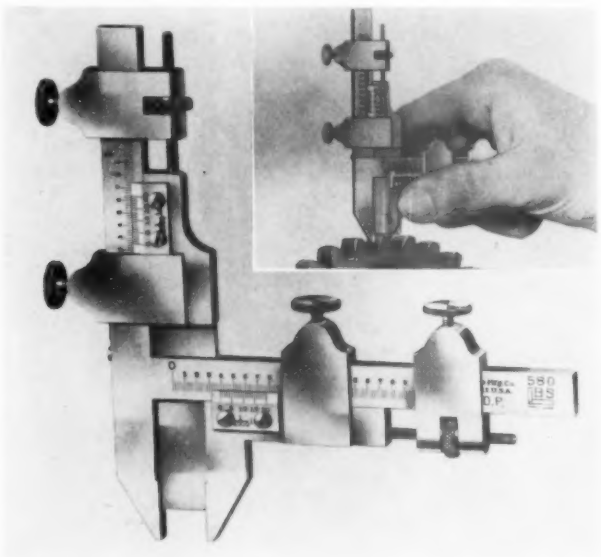


FIG. 13. Vernier gear tooth caliper, for simultaneous measurement of addendum and tooth thickness of gears.

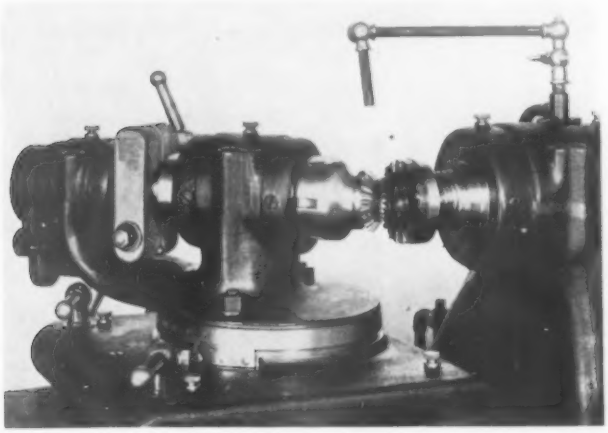
FIG. 14. Micrometer scratch gage, used principally for marking off full tooth depth of bevel gears.

Almost coincidentally with the introduction of the generator, by Brown & Sharpe's, two radical developments—the Fellows Gear Shaper and the Gleason Bevel Gear Generator—practically revolutionized the art of gear cutting. The one, invented by Edwin R. Fellows in 1896, generates spur gears by means of reciprocating cutters that produces truly accurate gears and at speeds previously unapproached by any other method. Fellows also introduced the *stub tooth*, which combines the tooth thickness of a coarser pitch with the

FIGS. 15 and 16. Serrated "cutters," developed by Brown & Sharpe's and used for generating gear teeth after milling with rotary cutters. Ca. 1900.

addendum and tooth depth of a finer—as, for example, 4-6 pitch, 6-8, 8-10 and so on.

The Gleason system also employs reciprocating cutters, but single point, in which two cutters plane both sides of a tooth simultaneously. Because the line of action—or reciprocation—converges at the exact center of the gear, bevels so generated are true, in tooth form, from O.D. to the small diameter. However, both of these systems are treated in separate



FIGS. 17 and 18. Machines used for generating gear teeth. Ca. 1900. These machines, and the cutters shown in Figs. 15 and 16, were invented by Oscar J. Beale, of the Brown & Sharpe Mfg. Co., in 1898 and are the forerunners of modern gear shaving machines.

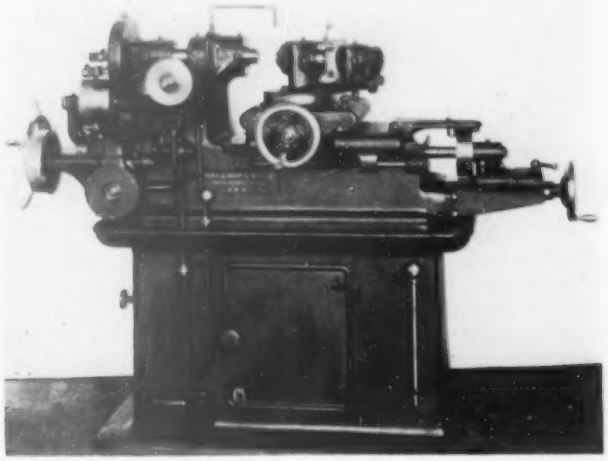
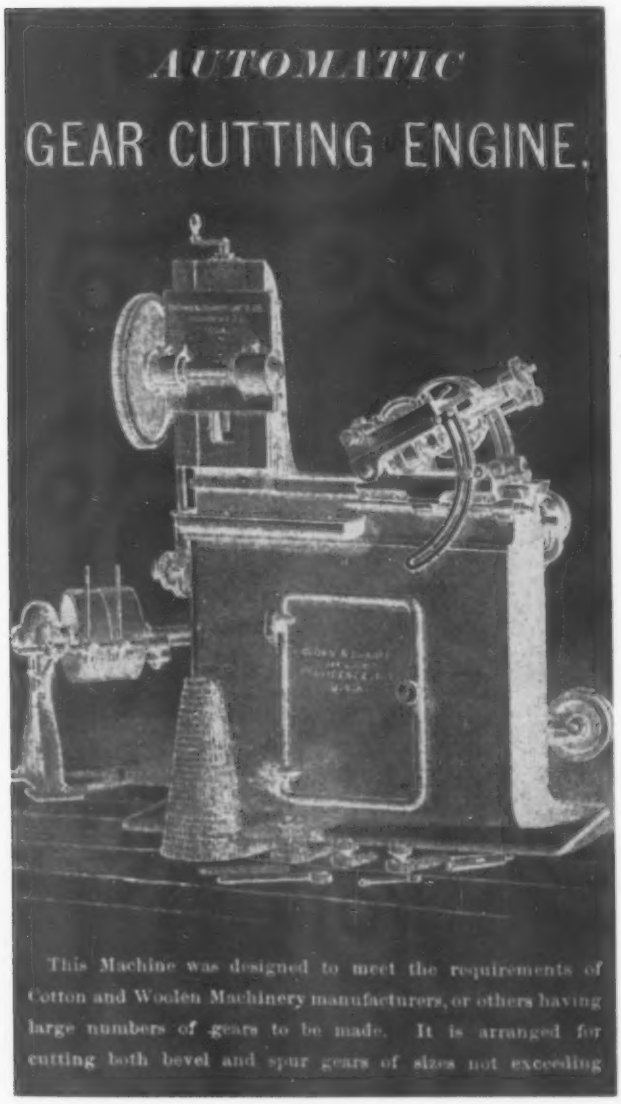


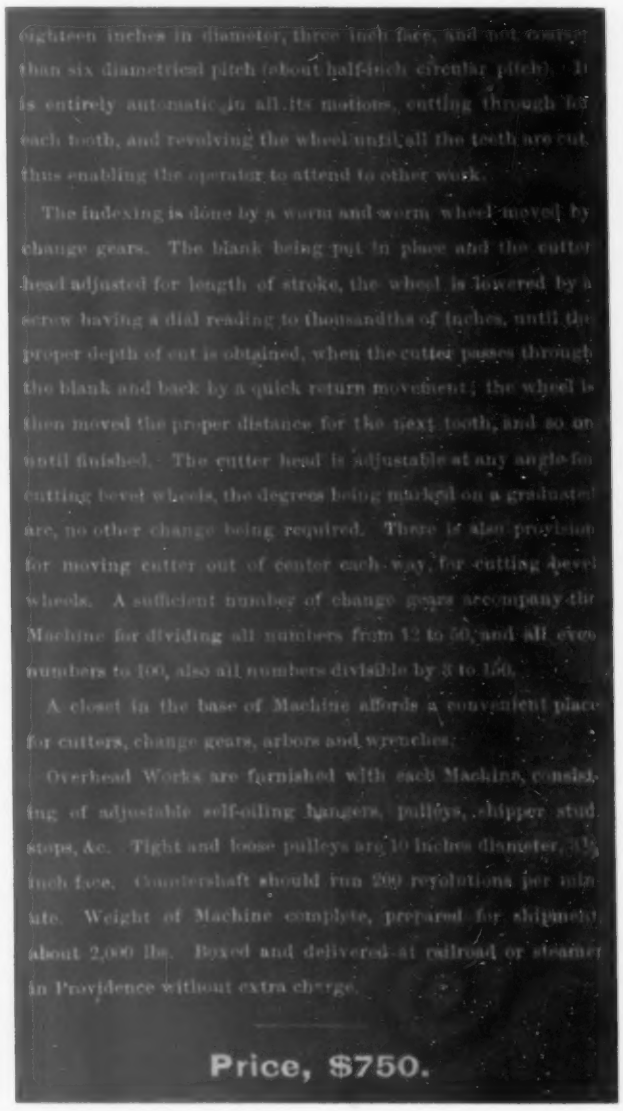
FIG. 19. Pages from Brown & Sharpe catalog of ca. 1880, describing the first "line" of automatic gear cutting machines to be manufactured in America. Of historical interest—e.g., note the price ($750) as compared to modern machine tools.



AUTOMATIC

GEAR CUTTING ENGINE.

This Machine was designed to meet the requirements of Cotton and Woolen Machinery manufacturers, or others having large numbers of gears to be made. It is arranged for cutting both bevel and spur gears of sizes not exceeding



eighteen inches in diameter, three inch face, and not coarser than six diametrical pitch (about half-inch circular pitch). It is entirely automatic in all its motions, cutting through for each tooth, and revolving the wheel until all the teeth are cut, thus enabling the operator to attend to other work.

The indexing is done by a worm and worm wheel moved by change gears. The blank being put in place and the cutter head adjusted for length of stroke, the wheel is lowered by a screw having a dial reading to thousandths of inches, until the proper depth of cut is obtained, when the cutter passes through the blank and back by a quick return movement; the wheel is then moved the proper distance for the next tooth, and so on until finished. The cutter head is adjustable at any angle for cutting bevel wheels, the degrees being marked on a graduated arc, no other change being required. There is also provision for moving cutter out of center each way, for cutting bevel wheels. A sufficient number of change gears accompany the Machine for dividing all numbers from 12 to 50, and all even numbers to 100, also all numbers divisible by 3 to 150.

A closet in the base of Machine affords a convenient place for cutters, change gears, arbors and wrenches.

Overhead Works are furnished with each Machine, consisting of adjustable self-oiling hangers, pulleys, shipper stud stops, &c. Tight and loose pulleys are 10 inches diameter, 3½ inch face. Countershaft should run 200 revolutions per minute. Weight of Machine complete, prepared for shipment, about 2,000 lbs. Boxed and delivered at railroad or steamer in Providence without extra charge.

Price, $750.

articles in this Symposium, and we will not expand on them here. Sufficient to say that they effected the eventual obsolescence, as far as mass production is concerned, of rotary gear cutting.

Again, however, a statement is advanced with reservations. It is true that, in view of later developments, rotary cutting of gears proved uneconomical for mass production, and that as a result the manufacture of rotary gear cutting machines has been discontinued. However, these machines are still in demand and will doubtless continue to be used for many years—at least, until those now in use are worn out.

One must, also, differentiate between rotary milling, with a single pass per tooth, and gear hobbing in which all of the teeth are cut at one pass—that is, in one forward feed movement of the carriage. Such machines are not only economical for gear cutting and many kindred operations, but are indispensable for the generating of worm wheels. These machines have weathered the test of time and, to a considerable extent, the demands of modern mass production.

In the past fifty years, however—that is, from the invention of the gear shapers to the present time—refinements in machines, tools and methods have followed at an accelerating pace. Several companies, as Michigan Tool Works and National Broach & Machine Co., have refined gear shaving to a high degree, as has the Fellows Gear Shaper Company. Among recent "revolutionaries" is the "Shear-Speed" gear shaper, introduced by Michigan Tool Works and discussed in this Symposium. Also, among recent developments, induction hardening is superseding the furnace in the heat treating of gears, while metallurgists are constantly refining metals to reduce distortion and to prolong life.

Coincidentally, the grinding of gear teeth—by generating and form grinding—has become a "must" in gear processing, and a number of concerns, notably Pratt & Whitney and the Gear Grinding Machine Co., have developed this art to a high degree of perfection. This technique, too, as well as gear lapping, is treated in this Symposium. In addition, although not discussed here, gears may be cut by broaching, and while this phase is mainly confined to internal gears and splines, external teeth may also be broached with considerable speed and within close limits of tolerance.

The foregoing, however, but brings out the highlights in the evolution of gearing. So many individuals and concerns, here and abroad, have contributed to the art that, to include all, one would require volumes—and volume upon volume has been written without exhausting the subject. And more is to come, for the gear, with methods for its manufacture, is still in a stage of evolution.

Gear Shaping—The Fellows System

by Edward W. Miller

IT IS INTERESTING to think back to fifty years ago and recall the methods employed in manufacturing gears at that time. Many gears were cast with no finishing operations. The better gears were form milled or cut with a forced single point tool. The tooth forms in use at that time were primarily based on the cycloidal curve or that in combination with the involute. The full involute tooth form had not come into universal usage due to inability to manufacture it accurately enough to avoid serious interferences. Inspection equipment for accurately checking tooth shapes was practically unknown.

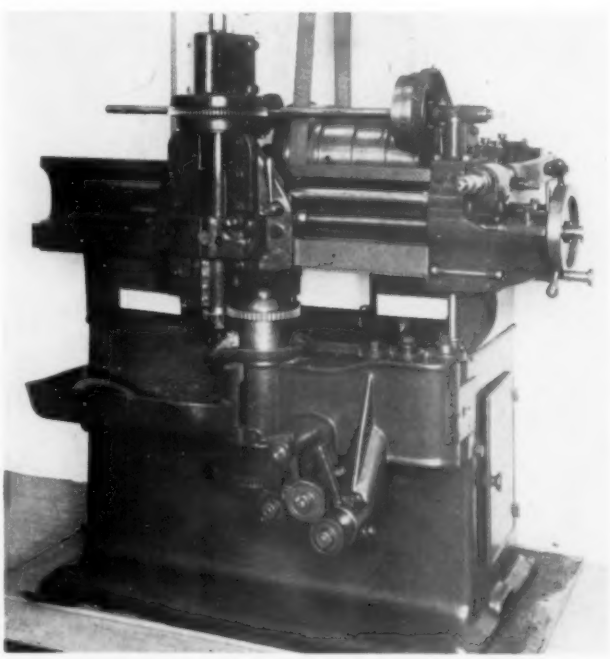
During the years of 1889 to 1896 inclusive, Edwin R. Fellows was engaged in designing turret machinery. In that period he frequently considered the problem of making more accurate and, therefore, more satisfactory gears, at a higher rate of production. His thoughts along these lines resulted in the development of the Gear Shaper.

Edward W. Miller **joined the Fellows Gear Shaper Company in 1898 and, for many years, served as Chief Engineer. Now General Manager, he has been a force in developing the company's product. A pioneer in modern gear manufacture, he is a past president of the American Gear Manufacturers Association and author of many articles on gear manufacturing. He has also been active among the National Machine Tool Builders.**

After the development of the lathe, planer, and milling machine, which are fundamental machine tools, it is probable that the next great machine tool invention was the Gear Shaper. It was radical; it was wholly new. It was and is unique, in that it made use of a principle little understood up to that time. Most inventions and developments made use of principles understood, but comprising unique modifications and applications of those principles.

Mr. Fellows appreciated the possibilities of the involute gear and built his Gear Shaper with the idea of producing involute gears only. He employed a gear-shaped cutter provided with proper cutting edges. The cutter reciprocated and rotated in harmony with the gear being produced. His first machine was finished in 1897 and this machine is now a part of the machine tool exhibit permanently located in Rockefeller Center in New York City. That machine is illustrated in Fig. 1. In acknowledgment of this splendid work, Mr. Fellows was awarded the John Scott Medal by the city of Philadelphia 1899, upon the recommendation of the Franklin Institute.

Fig. 1



The Gear Shaper made use of the molding-generating principle, which means that the cutting tool in its operation rolls with the work and develops a counter-part commonly known in gearing as a conjugate. A tool of this character provided with cutting edges must occasionally be sharpened. This results in a decreased center distance between tool and work, as the tool is progressively sharpened. This works out satisfactorily with involute gears, which for many other reasons are the most practicable type of gear teeth. Subsequent developments have indicated the possibility of generating many other types of toothed members by this gear shaping process.

The Gear Shaper came into being at the same time that the automobile was being developed and as this industry increased, the Gear Shaper made possible the automobile transmission as we have known it. More accurate gears were produced thereon than had been previously made and they were produced more rapidly. As the Gear Shaper Cutter is a reciprocating tool with all its cutting edges lying in the same plane, it was possible to cut gear teeth close to a shoulder. Therefore, a more compact design of automobile transmission became possible. This resulted in the adoption of the cluster gear and other recessed members. For the same reason it was also possible to cut internal gears, since this tool could readily enter such a member. As a result, the Gear Shaper took its place as one of the most important machine tools in industry.

Progressively the requirements increased, both with respect to production and accuracy. As a result, it was necessary to create a dependable inspection system and to develop equipment which might be marketed for the use of the customer in determining the accuracy of his product, as well as to inspect the cutters. This consisted of instruments for checking the involute profiles, circular pitch, pitch line run-out, composite errors, side clearance on cutters, and an accurate means of checking tooth proportions. This was naturally a slow process, but it kept reasonable pace with the need.

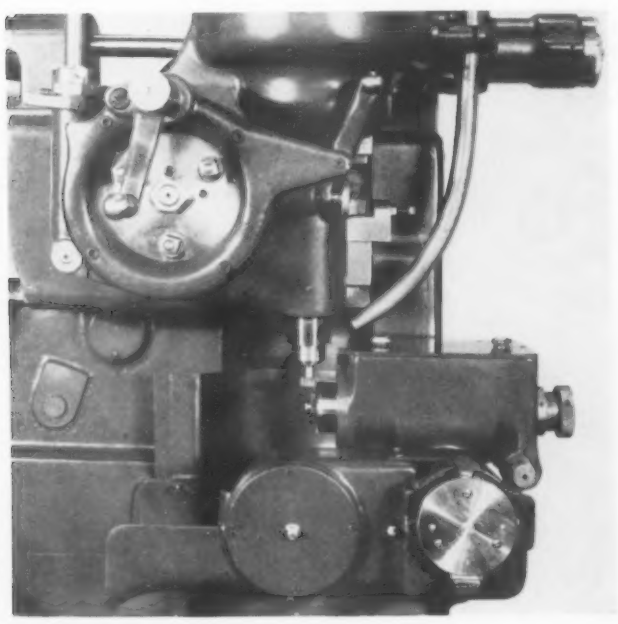
In due course the helical gear, which was known but not widely used, was incorporated as the timing gear of the automobile, and later in the transmission. This challenge was met through the development of a Helical Gear Shaper. This machine was essentially the same as the Spur Gear Shaper, but it was provided with a cutter developed at proper helix, and with proper cutting edges, and controlled through the medium of a helical guide of the same helix lead as that of the cutter. With this trend to helical gears came the need of further inspection equipment, such as that for lead checking.

When the method of producing gears by a forming tool or milling cutter was in vogue, a root clearance which was .157 divided by the diametral pitch, or approximately 16% of the addendum length, was established as a standard. The use of a generating cutter, like that of the Gear Shaper, required a greater depth, developing a deeper and longer fillet or trochoid. The parabola method of investigation of tooth strength, used at first, seemed to indicate a weakened tooth by reason of this extra depth, but experience has shown that such a tooth is in reality stronger, since it greatly reduces the possibility of concentration of stresses.

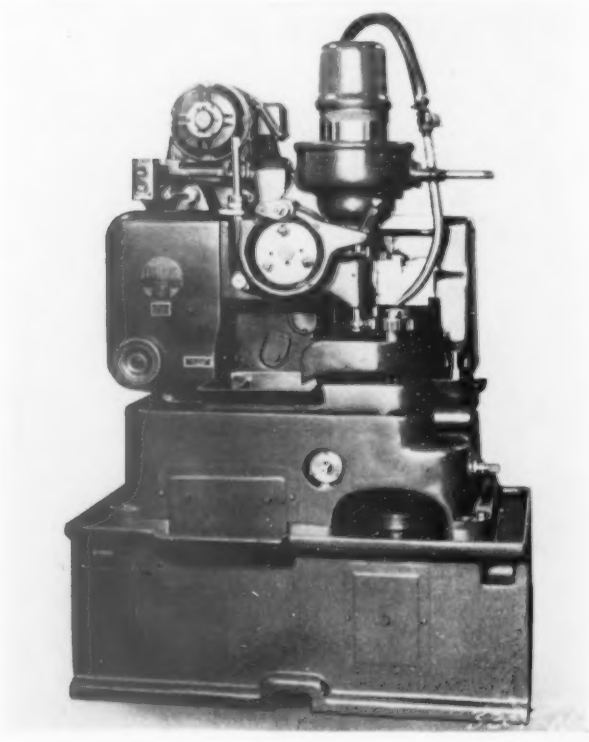
In earlier days cut gears were made very heavy and in coarse pitches to avoid breakage. Among the reasons for doing this was the unavoidable cutting errors of that period

Left, Fig. 2

Fig. 2A, below, machine used to generate Face Gear shown in Fig. 2



Below, Fig. 3

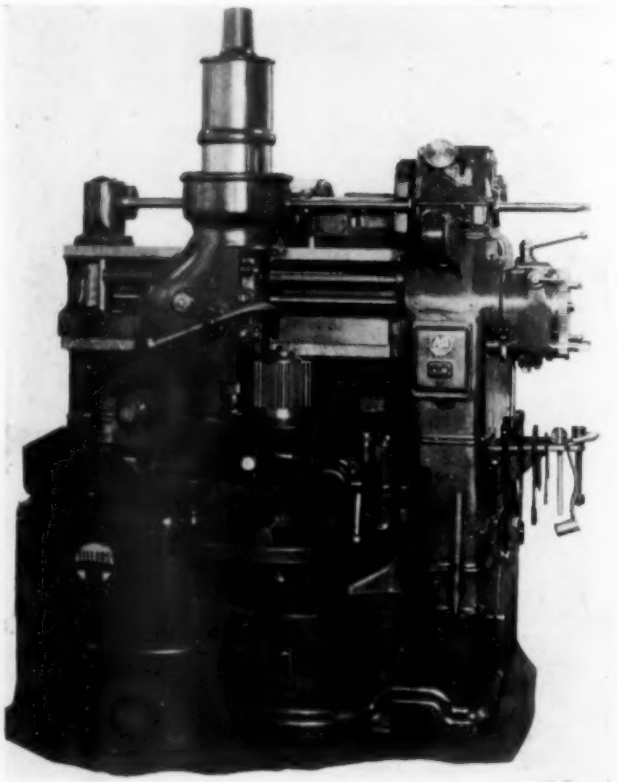


and the distortion of hardened gears resulting from the heat treatment. When using these coarse pitch gears, it was necessary to employ small numbers of teeth in the pinions to obtain high gear ratios in a reasonable space. To help correct these troublesome conditions, Mr. Fellows suggested the use of the Stub Tooth Gear, employing a 20° pressure angle, which was soon extensively adopted. This new design had a stronger tooth, less distortion during heat treatment, and permitted the use of smaller numbers of teeth without the dangers of involute interference. This stub tooth design was the best answer in spur gearing for many years and is still widely used in helical gearing. As more accurate spur gears were produced, the trend was back to a full length tooth to get more involute action, but the 20° pressure angle has in general been unchanged. The dangers of involute interference has been avoided by employing long and short addendums. Helical gears do not necessarily need this increased involute action, as their helical action assures smooth continuity.

The Fellows Gear Shaper Company was the first to develop the Face Gear. It is naturally the result of the gear shaping method. A typical right angle Face Gear drive is shown in Fig. 2. In this drive one member is an ordinary gear or pinion having cylindrical elements. The Face Gear is usually cut and operated at right angles, but it can be cut to operate at any angle, external or internal.

The first Gear Shaper was a machine of relatively wide range, cutting gears from practically a zero diameter to 36 inches in diameter, 5 inches maximum face, and handled diametral pitches from 4 to 64. The developing requirements for gears resulted in the design of several types of Gear Shapers, not all of which had the universality of that original machine. It is noteworthy that even today there is a requirement for that old machine—a tribute indeed to the genius of the inventor, E. R. Fellows.

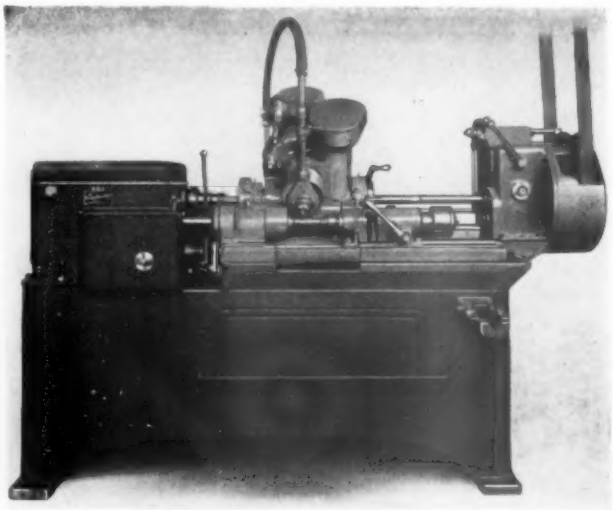
This old machine was the only product of the Fellows Gear Shaper Company during World War I. Through World War II more than forty different kinds of machines have been made and marketed. These include measuring devices.



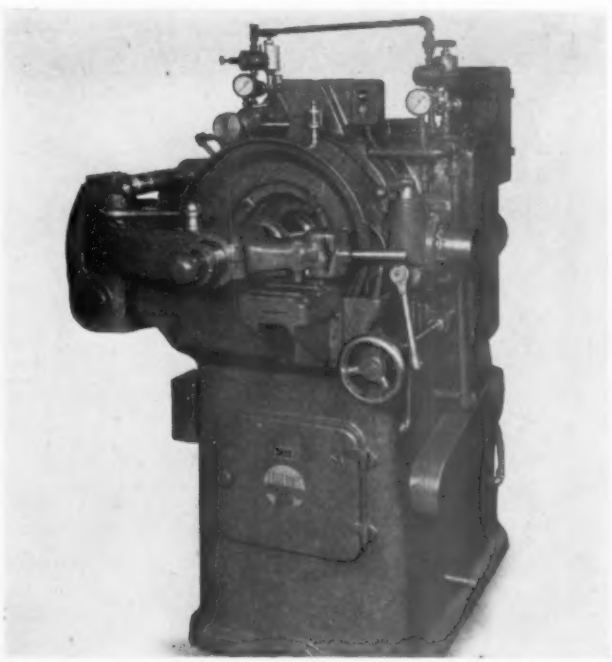
The original machines were known as the number 6 series. Following World War I there was a demand for a lighter high speed Gear Shaper to handle automobile transmission gears, and the like. This brought forth the number 7 series Gear Shapers illustrated in Fig. 3. Later a definite demand for a high speed 18-inch capacity machine was manifest. This was met by the development of the number 6A series. This is shown in Fig. 4.

During that period the Fellows Gear Shaper Company also brought out the Thread Generator, Fig. 5. This machine was distinctively new in that it generated the worm threads instead of milling or chasing them. This machine not only cut a more accurate worm thread, but was a much faster producer. That answered, in part, the battle cry of the times, which was "Faster Production."

Gear burnishing machines were developed, but never played a very great part in the production of hardened steel or cast iron gears. The burnishing of steel gears which are not hardened has proven extremely helpful in many cases where the requirements were exacting.



Left, Fig. 4, Above, Fig. 5, Below, Fig. 6



When lapping hardened gears, it was found that no one type of machine was satisfactory for both spur and helical, external and internal gears. If external spur gears are lapped by running them with external laps, there is a pronounced tendency to destroy the tooth profile of the work. An external spur gear should be lapped with an internal lap, such as that employed in the LS-type Lapping Machine shown in Fig. 6. An external helical gear can be satisfactorily lapped in this manner or in a nest of three external laps on parallel axes. Because of simplicity and its fine performance, the three-lap setup is usually employed for external helical gears and is illustrated in Fig. 7. Internal spur and helical gears are lapped by a single external lap.

This type of Lapping Machine rotates the work and laps, which are loaded by brakes, and also has a reciprocating action between the work and laps. By using different combinations of rotating speeds, reciprocating speeds, and brake loads, various results can be had, such as obtaining mild modifications in the profile, or a slight crowning lengthwise of the tooth.

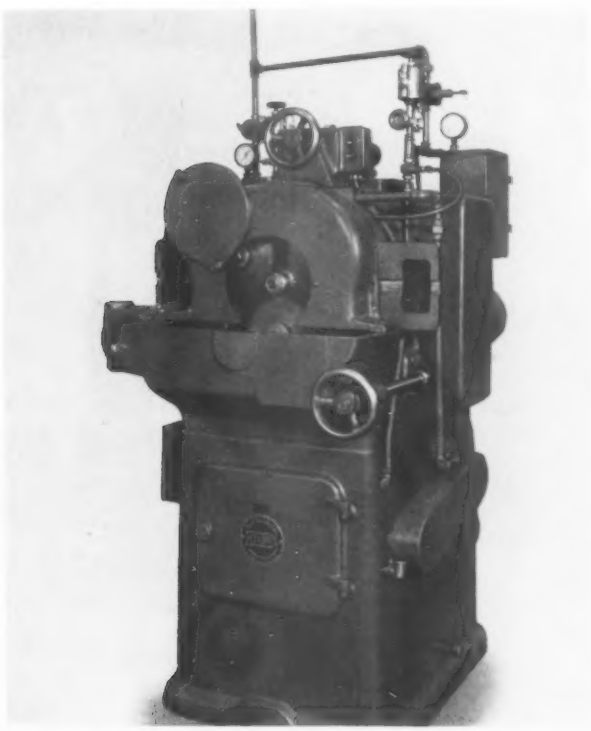


Fig. 7 above

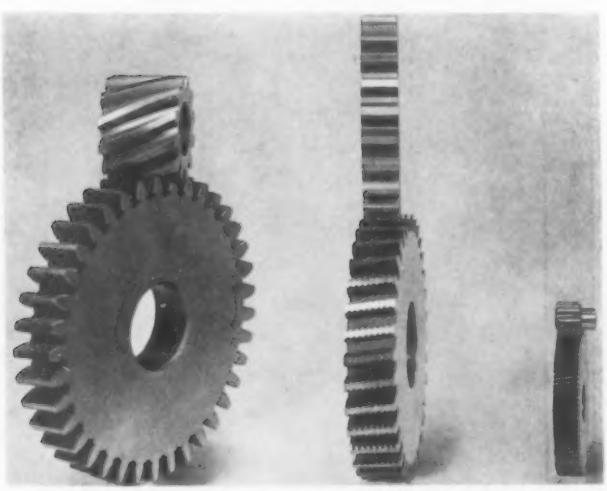


Fig. 8 below

One important development has been that of gear shaving. Gear shaving is a process of refining gears at an extremely low cost. This operation removes only about .002 to .003 from the tooth thickness of gears in the vicinity of 8 to 16 diametral pitch. On coarser or finer pitches, the stock removal should vary accordingly. A properly shaved gear has exceedingly good finish and accuracy. It is not desirable to shave gears harder than 30 or 35 Rockwell C, but harder gears can be shaved if a greatly increased tool cost is permissible.

Most shaving machines are of the rotary type, which employ a shaving tool similar to a master gear, except that it has grooves cut up and down the tooth profiles. A tool of this type is shown in Fig. 8. In the shaving operation the work and tool spindles are not geared together. In most cases the tool drives the work, but if the work is extremely heavy, it is better to have the work drive the tool. The

Fig. 9 above

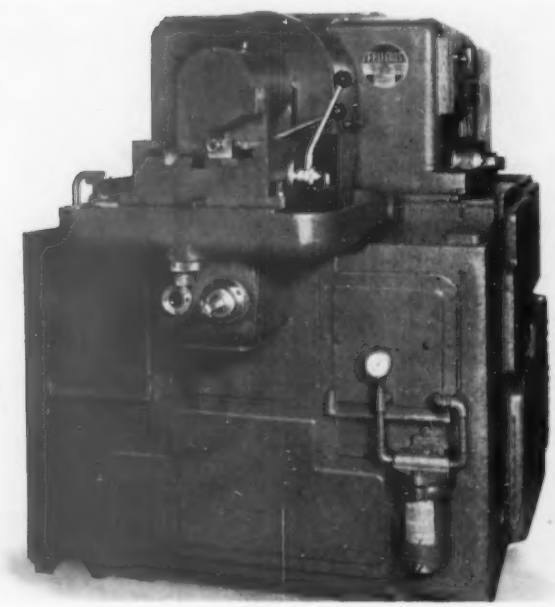


Fig. 10 below

cutting action in this process is obtained in two ways. One is to have the axes of the work and tool several degrees out of parallel. This gives an endwise skidding action between the teeth of the tool and those of the work which are running in mesh under considerable radial pressure. This necessitates the tool having a helix angle equal to the helix angle of the work plus or minus the angle that the centers are out of parallel, which is often called the cross axis angle. In case the work is spur, having no helix, the helix angle of the tool would equal the cross axis angle.

The best cross axis angle for most applications is between 10° to 18°. If too slight an angle is used, too little cutting is done and the action is principally that of burnishing, which is not usually desirable. If the cross axis angle is too great, there is too much cutting action, resulting in a rough finish and poorer accuracy due to insufficient control between work and tool. Because both the work gear and the shaving tool have cylindrical elements, they will not have theoretical contact across their entire face when set at a cross axis angle. For this reason it is best to feed the tool slowly across the face of the work a distance equal to or slightly more than the width of the work face, while tool and work are rotating. The point where the axes cross must be practically in the middle of the work face when the tool is in the middle of its feed travel.

In order to get approximately the same stock removal and finish on both sides of the work teeth, it is usually necessary to rotate the members in one direction half the time and in the other direction the other half of the time. A cross axis type machine is shown in Fig. 9.

The other method of getting cutting action is to stroke the tool or work rapidly while they are rotating under radial pressure. This permits the use of parallel axis which is advantageous in many applications. Frequently it is not possible to employ a cross axis angle great enough to be effective, because of a close shoulder or some other peculiarity of the work blank design. In such cases the fast stroking, parallel axis setup is the answer. This type of machine, shown in Fig. 10, is desirable for internal gears having protruding hubs. Many aircraft gears have been shaved in this way.

World War II so expanded the requirements for gear producing equipment that in one year the Fellows Gear Shaper Company designed and built nine strictly new machine tools. Subsequently through these busy years many

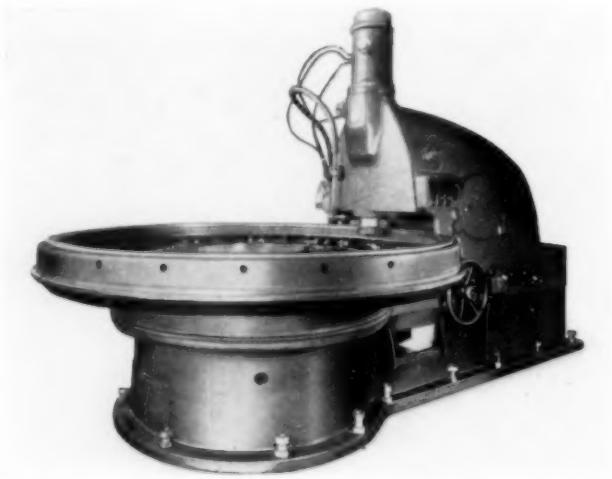


Fig. 11 above

Fig. 12 below

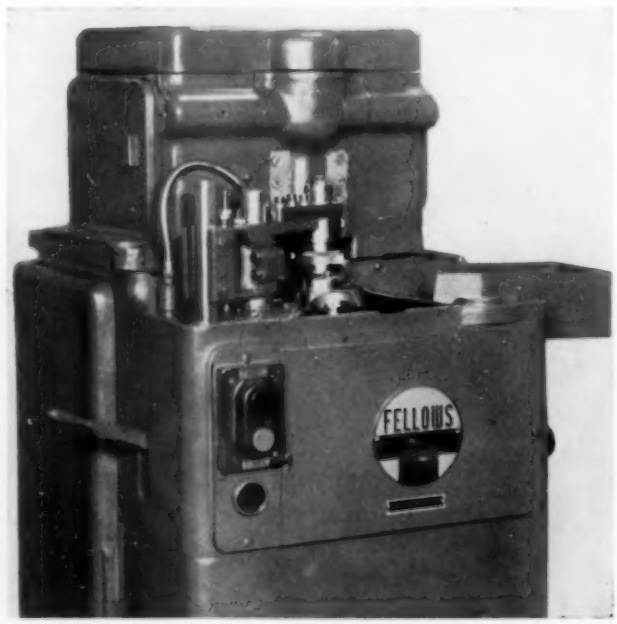


Fig. 13 above

Fig. 14 below

others were developed. One of the interesting items was that of a Gear Shaper which would cut gears as coarse as 2 diametral pitch and up to 100 inches in diameter. (See Fig. 11.) The capacity of this machine was increased in one instance to 119 inches.

In contrast to the 100-inch Gear Shaper a small Gear Shaper and involute cutters were developed to cut delicate instrument gears as fine as 272 pitch and as small as 1/16 inch in diameter. It is interesting to note that the standard tooth thickness of a 272 pitch tooth is .0058. The diametral pitch of 175 has been used extensively during this last war and that has a standard tooth thickness of .0090. Previous to World War II, the machines and cutting tools for these fine-pitch gears came principally from Germany and Switzerland. When hostilities became imminent, the Fellows organization was requested to help. They met the challenge by not only developing the above fine-pitch Gear Shaper, but also a fine-pitch Shaving Machine and a fine-pitch Burnishing Machine. These three machines are shown in Figs. 12, 13 and 14.

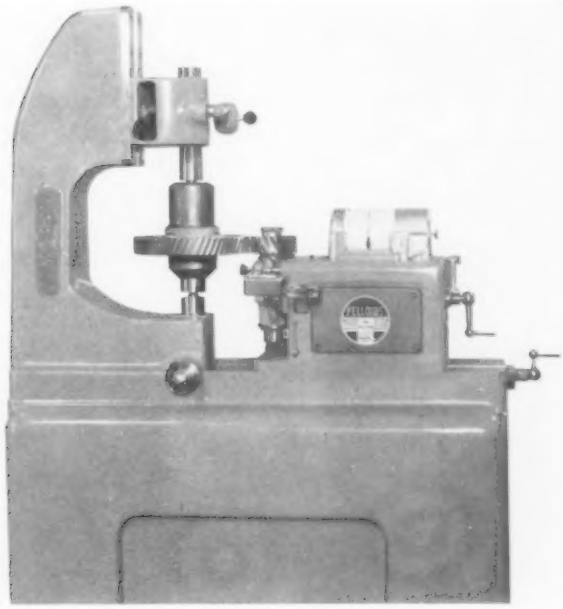


FIG. 15.

In order to get the best of good gear cutting and finishing equipment, it is necessary to have equally good inspection equipment. The most extensively used instrument, for making a composite check of gear errors, is the Red Liner illustrated in Fig. 15. This records the composite errors automatically on a chart. This also gives a direct record of pitch line runout. The tooth thickness, in terms of amount of backlash cut into the work, is read directly on a dial indicator.

When it is necessary to break down these composite readings into individual errors, it becomes necessary to check the involute profile, circular pitch, and pitch line runout. The involute measuring instrument in Fig. 16 is a quick setting device upon which the involute errors and amounts of modifications can be observed from a dial indicator, and then automatically recorded on paper at the will of the operator. These readings are to the nearest .0001.

Circular pitch and pitch line runout are easily checked on the 12-inch capacity instrument in Fig. 17. This is standardly equipped for dial indicator reading only. It is rapidly operated due to an automatic indexing device.

FIG. 16. Left.

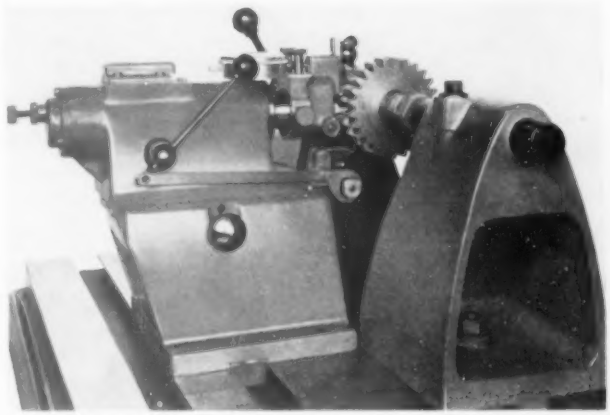


FIG. 17. Below.

Future demands will bring forth many developments, not only with respect to production means and methods, but the gears themselves will afford new problems. Since their design will inevitably be improved. Already the Fellows Gear Shaper Company has developed several new machines to meet the situation and they will soon be in the field.

Among other collaborators in this Symposium, we gratefully acknowledge the fine cooperation of Mr. George Sanborn who, for the past 20 years, has served as field engineer with the Fellows Gear Shaper Company.

Bevel Gear Manufacture The Gleason System

by George Hessler

A MODERN bevel gear cutting machine in good condition will cut a gear which is very nearly perfect provided that the blank is accurate and the machine is correctly set up and equipped with the proper cutting tools and work holding arbor. If this gear were to be inspected without disturbing its location on the machine on which it was cut no appreciable eccentricity would be found. However, the gear must be removed from the cutting arbor and machine for testing, hardening, grinding of the final mounting surfaces, and other operations. It is in operations other than the cutting that many of the errors which exist in the finished gear develop. It becomes obvious then that cutting a good gear does not necessarily mean having a good finished gear unless all the operations before and after cutting the teeth are correctly performed.

Bevel Gear Blanks

The manufacture of a good gear must begin with a good blank. Even when the cutting of the teeth is the final operation, a correctly cut gear may be a poor gear in the

assembly because of an oversize bore, runout on the axial, locating face, or other errors in the blank.

The sequence of operations and the type of equipment used for the production of bevel gear blanks varies widely depending upon size, quantity, quality, and the shape of the gears. In general, the machining processes and the tooling used are no different than would be used in the manufacture of any other accurate machine part of a generally similar shape. In the manufacture of gear blanks the primary requirement is that the blank as delivered to the gear cutting machine be in proper condition for cutting the teeth in accurate relation to certain important surfaces on the blank. The accuracy required in the blank should be determined by the accuracy requirements of the finished gear.

George Hessler **acquired his technical education at Youngstown, Ohio, Inst. of Technology and Mechanics Institute, Rochester, N. Y. Joining the Gleason Works, Gear Engineering Dep't, he was successively with the Industrial Engineering, Estimating and Gear Methods departments. For the past several years, has been Superintendent of gear manufacture and the manufacture of chucking and hardening equipment.**

The most important surfaces on a gear blank are the surfaces which are used for locating the gear radially and axially on the gear cutting machine. As a general rule, particularly in the case of unhardened gears, these are also the surfaces which are used for mounting the gears in the final assembly. Of equal importance in the case of hardened gears are the reference or locating surfaces which are provided for use in operations subsequent to the cutting of the teeth, such as the die quenching operation and the subsequent grinding of the mounting surfaces. When the size and shape of the gear permit, it is preferable to use the same locating surfaces for cutting, testing, quenching, and grinding, to avoid an accumulation of errors and to eliminate the necessity of machining numerous surfaces to close tolerances.

Space does not permit the specifying of bore tolerances for all sizes and classes of gear blanks. As a general rule, in small and medium sizes, the bores of blanks for industrial gears of good quality are held to +.0005" −.0000" This would be reduced to +.0002" −.0000" for gears of a precision nature and, if extreme precision is required, the bores should be a "wring" fit on the cutting arbor.

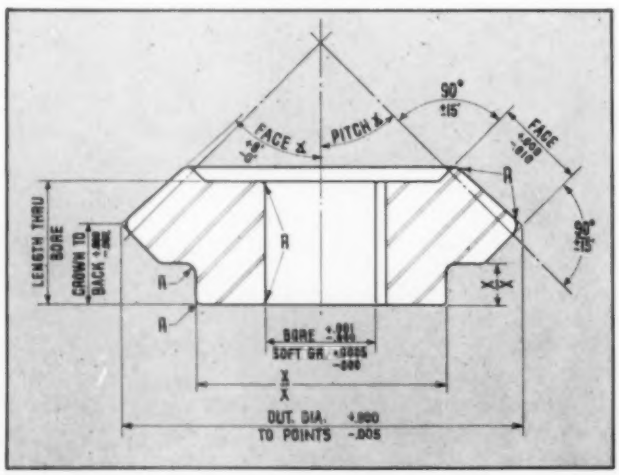
The axial locating surface, which in the case of the conventional type of gear blank shown in Fig. 1 is the back face of the hub, is fully as important as the bore. It is essential that this surface be flat and true with the bore within close limits. The total axial runout should not exceed .0005" for good quality gears of the size shown in Fig. 1 and may be required to be much less in the case of precision gears.

The importance of the locating surfaces cannot be emphasized too strongly. The testing operation after cutting the teeth may become meaningless, unless it is possible to mount the gear for testing exactly the same as it was mounted when the teeth were cut. When bores are loose and axial surfaces run out, this is not possible, and much time may be lost tracing errors which exist only in the blank.

There are certain other surfaces which should be held within specified limits for the best results. See Fig. 1. Except for the radial and axial locating surfaces, these tolerances are applicable to all classes of gears other than very large gears, or to small, fine pitch gears such as are used in instrument work.

Fig. 2 is a typical operation sheet which might be used for producing the gear shown in Fig. 1 in medium quantities.

FIG. 1. Typical bevel gear blank.

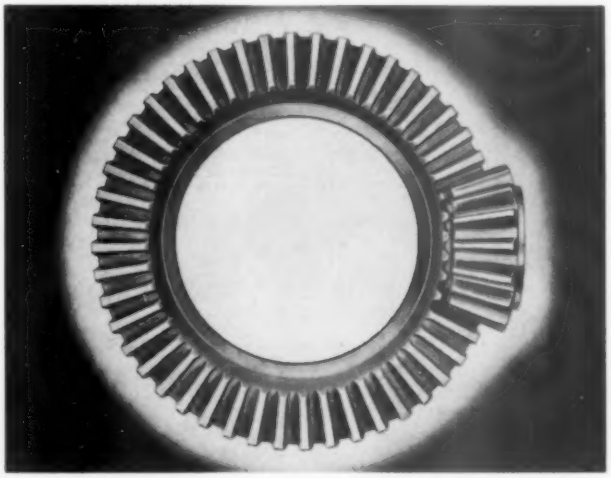


OPERATION SHEET

Straight Bevel Gear — Gleason Works

NAME OF OPERATION	NAME OF TOOL
The first rule in all operations is SAFETY	
Cut off stock	
Rough front and front angle, face angle and back angle	Turret Lathe
Chuck on face and back angle, rough and finish end of hub, hub diameter and shoulder, drill, rough and semi-finish bore	Turret Lathe
Finish O.D. and flat on front for chucking, and face front of hub to length	Engine Lathe (Double compound)
Radius corner at front of bore, reverse and radius other end	Engine Lathe
Broach keyway	Broach
Soft grind bore and back face of hub	Internal Grinder
Finish face angle, back angle, and front angle, and radius corners at both ends of face	Engine Lathe (Double compound)
Chamfer ends of keyway	Bench
Rough Cut Teeth	Gleason #18 Roughor Gleason Automatic Tools
Finish Cut Teeth	Gleason 12"B Generator
Chamfer ends of teeth	Bench or Tooth Chamfering Machine
Soft test	Gleason #1 Test Machine
Carburize	
Harden	
Clean	
Grind bore	Internal Grinder Pitch line check
Hard test	Gleason #1 Test Machine
Stores	

FIG. 2. Above, Operation sheet. *FIG. 3.* Below, Straight bevel gears.



Types of Bevel Gears

Before discussing the methods of producing the teeth and the machines and tooling used, it may be pertinent at this point to describe briefly the various types of bevel gears in common use, their application, type of tooth bearing, and other general characteristics.

Straight bevel gears (Fig. 3) are the simplest form of bevel gears. They have straight teeth which if extended inward would intersect at the axis of the gear. Their use is generally limited to drives which operate at relatively slow speeds. While it is not possible to establish an absolute maximum in terms of feet per minute beyond which straight bevel gears should not be used, it is generally recommended that spiral bevels be used when the speeds are in excess of approximately 1000 surface feet per minute, or in the case of very small gears 1000 R.P.M. Obviously there are many factors which affect these values, the most important of which are smoothness and quietness requirements, load carrying capacity, mounting conditions, accuracy in the manufacture of the gears and housings, and accuracy in assembly of the gears.

Spiral bevel gears (Fig. 4) have teeth which are curved and oblique. The inclination of the teeth of spiral bevels results in gradual engagement and continuous pitch line contact or overlapping action which insures more than one tooth in contact at all times. Because of this continuous contact, the load is transmitted smoothly from tooth to tooth, which, assuming accurate manufacture, results in extreme smoothness and quietness even at very high speeds. These features result in greater load carrying capacity than can be obtained with straight bevel gears of the same size.

Spiral bevel gears are used in practically all types of equipment where it is necessary to transmit heavy loads smoothly and quietly at high speeds. They are also widely used in low speed applications where extreme smoothness of operation is an important consideration.

Zerol gears (Fig. 4) are curved tooth bevel gears with zero-degree spiral angle. In other words, the teeth are not oblique as is the case with spiral bevel gears. They are produced on the same machines and with the same type of cutters as are used for spiral bevel gears.

Zerol gears are generally used in the same types of drives as straight bevel gears. As in the case of straight bevels, Zerol gears have no inward axial thrust and therefore they may be used in mountings originally designed for straight bevel gears without the addition of thrust bearings. Since Zerol gears may be used in place of straight bevels, the fact that they are produced on the same equipment as spiral bevel and hypoid gears is important from the standpoint of economy, because it eliminates the need for more than one type of bevel gear cutting equipment.

When, because of design conditions, it is not possible to make adequate thrust provisions to permit the use of spiral bevels, Zerol gears are sometimes used instead, because the teeth of Zerols, up to approximately 20" diameter, can be ground to the accuracy required for operation at relatively high speeds.

Hypoid gears (Fig. 4) are similar to spiral bevel gears in general appearance. There is an important difference, however, in that the pinion axis of hypoid gears is offset above or below the gear axis. This feature provides many design advantages as may be seen by a brief study of the two designs shown in Figures 5 and 6. In operation, hypoid gears run even more smoothly and quietly than spiral bevel gears and are somewhat stronger.

Hypoid gears were first used in the automotive industry. Their use has now developed to the point where they are used in practically every automobile built in this country or elsewhere in the world. Their operating smoothness and the practicability of lower bodies because of the offset below center of the pinion axis has been of great importance to the automotive industry. In the general industrial field they are also very widely used because of the many design possibilities which are offered by the ability to cross the gear and pinion shafts.

Spiral bevel, Zerol, and hypoid gears are of two types, namely, generated and Formate. In appearance, they are nearly identical, the only difference between them being a slight variation in the profile shape of the teeth. In a generated pair, the teeth of both the gear and pinion are cut with generation, whereas in a Formate pair, only the pinion member is generated, the teeth of the gear being straight-sided. In generating a pinion to operate with a Formate gear the tooth profile is modified to compensate for the lack of profile curvature in the gear tooth. There is no difference in strength, smoothness, and efficiency, between Formate and generated gears. For tooth design reasons, the Formate system is limited to ratios of approximately 3-1 or higher.

Formate gears were developed primarily for economic reasons. Since no generating roll is required when cutting the gear member, it can be cut several times faster than a generated gear of the same specifications. It takes no longer to cut the mating pinion than it does to cut the same pinion to run with a generated gear. For these reasons, the Formate type of gear is widely used in products that are manufactured in mass production quantities. Nearly all American cars, and many of foreign make, use Formate gears for the rear axle drive.

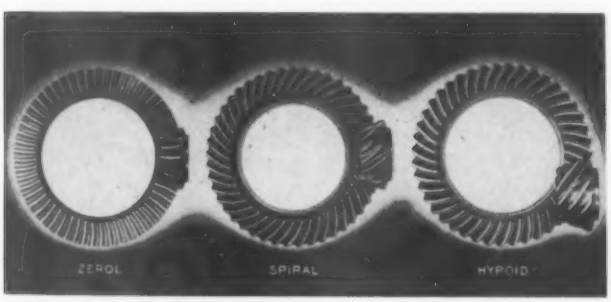


FIG. 4. Zerol, spiral bevel, and hypoid gears.

FIG. 5. Typical industrial hypoid gear application.

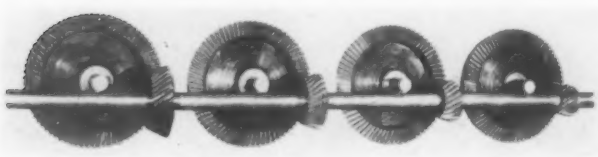
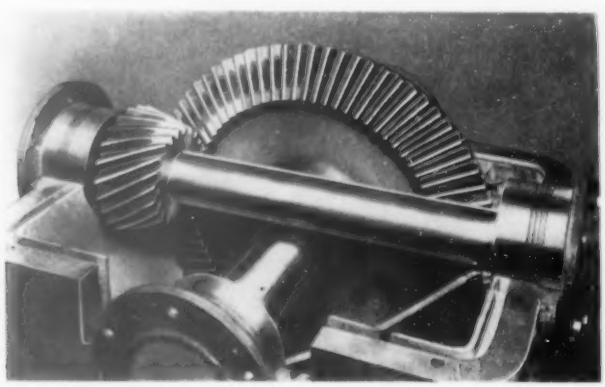


FIG. 6. Hypoid gear application, gear and pinion straddle mounted.



Tooth Bearings of Bevel Gears

One of the most important factors in the success or failure of heavily loaded gear drives is the character and the location of the tooth bearing when the gears are under load. When, because of housing and bearing deflections or slight errors in positioning of the gears in assembly, the load becomes concentrated at one end of the teeth, early failure of the gears is almost sure to result. Since deflections take place and since it is not practical to machine and to assemble gear boxes without a working tolerance, it is desirable that tooth bearings be such that slight errors, or displacements under load will not cause the concentration of the load at the extreme ends of the teeth.

To meet this requirement all straight bevel, spiral bevel, Zerol, and hypoid gears which are produced on the latest Gleason generators have the teeth cut with a localized tooth bearing. (See Figures 7 and 8.) Spiral bevel, Zerol, and hypoid gears have always been produced with this type of tooth bearing, but its application to straight bevels is a comparatively recent development.

The degree of localization and the position of the contact area on the tooth is controlled readily in the manufacturing operations. Thus it is possible to locate the contact area on any desired portion of the tooth to compensate for known but unavoidable deflections of the assembly under operating load. Furthermore, allowances can be made in cutting for known changes in the tooth bearings as a result of heat treatment.

Cutting Machines and Methods—Straight Teeth

The teeth of straight bevel gears up to approximately 35" pitch diameter for general purpose use and for machine tools and other precision applications are cut by the generating process. Three sizes of straight bevel generators cover this range of work. The generating principles and the type of cutting tools used are similar on all three machines.

On these generators, the finish cutting is accomplished by two tools mounted in blocks on reciprocating slides which, in turn, are mounted on a cradle. During generation, the cradle rolls in relation with the work spindle on which the gear blank is mounted. As the tools and gear blank roll together, the tools reciprocate across the face of the gear blank in a series of cuts which produces the tooth shape. At the end of the generating roll the blank is withdrawn from engagement with the tools, and the cradle and work spindle roll back to the starting position for the next tooth. The indexing of the gear blank takes place during the return roll. Fig. 9A and B illustrate the related motion of the blank and the tools. Fig. 10 shows one of the modern straight bevel gear generators.

When quantities are not large enough to justify the use of a roughing machine, the rough cutting operation is performed on the same machine as the finishing, but in a separate chucking. During the roughing no generating motion is used, the blank being fed straight into the tools.

Several types of roughing tools may be used in the straight bevel gear generators, the simplest being the "V" shaped tool which is used for gears of 6 D.P. and finer. This type of tool is used for relatively small quantities. For moderate quantities in the same size range a formed tool known as the Gleason "Acruf" tool is preferred since it roughs the teeth much closer to the finished shape than the "V" tool with a resultant saving in time and tool life in the finishing operation.

A third type of roughing tool is used for heavy pitches. This is a combination slotting and side cutting tool arranged in tandem fashion, the side cutting edge following the slotting portion. This tool is known as the Gleason "Tanruf" tool.

A method of roughing which is used to good advantage on gears having a relatively large number of teeth is the "double index" method. It is used to greatest advantage on flat gears having a face width not exceeding ¼ of the cone distance.

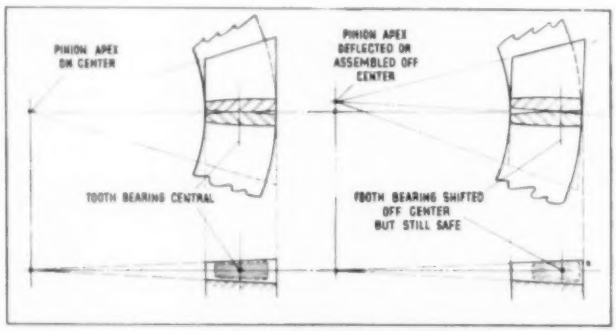

PINION APEX ON CENTER
PINION APEX DEFLECTED OR ASSEMBLED OFF CENTER
TOOTH BEARING CENTRAL
TOOTH BEARING SHIFTED OFF CENTER BUT STILL SAFE

FIG. 7. Advantage of localized tooth bearing—straight teeth.

FIG. 8. Advantage of localized tooth bearing—curved teeth.

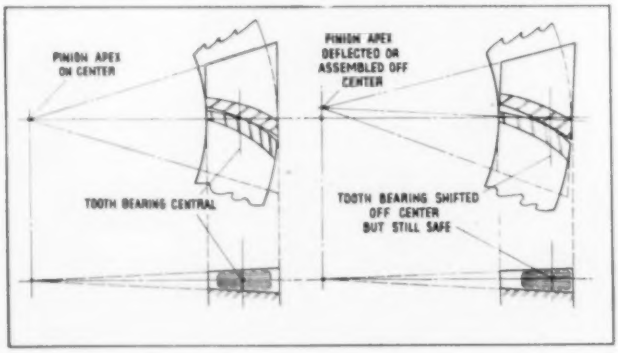
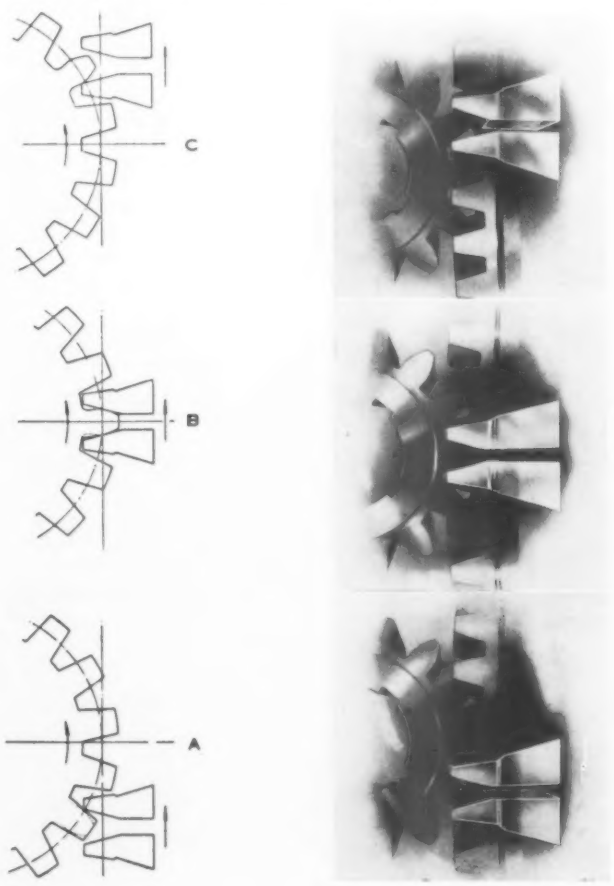

PINION APEX ON CENTER
PINION APEX DEFLECTED OR ASSEMBLED OFF CENTER
TOOTH BEARING CENTRAL
TOOTH BEARING SHIFTED OFF CENTER BUT STILL SAFE

FIG. 9A and B. Principle of bevel gear generation.



By this method two slots are roughed at each indexing, the index mechanism being arranged for half the number of teeth in the gear being roughed.

A machine specially built for roughing is used when the quantities to be made are moderately large. Gears up to 18" pitch diameter, 4 D.P., 2½" face, may be roughed to advantage in this machine. In appearance and cutting operation it is similar to the generator except that no generating motion is available, but it has the advantage of greater rigidity and operating conveniences for roughing purposes. The roughing tools which are used in this rougher are the same as those used in the generators.

For roughing straight bevel gears up to 14" pitch diameter, 4 D.P., 2" face, in production quantities, a new type of rougher is available which utilizes the combination of a rotating cutter with a relatively rapid stroke. A disc type cutter with blades extending radially outward from the center is mounted to rotate in a horizontal plane. The blank is held motionless during the cut, and the slide carrying the cutter is moved horizontally parallel to the root line of the gear as the cutter rotates. Very close roughing is obtained by the combined effects of the shape of the cutter blades and the horizontal motion of the cutter.

One of the most unique and by far the most rapid method of cutting straight bevel gears with conjugate tooth surfaces is that known as the Gleason "Revacycle" process. Gears up to approximately 10" pitch diameter, 5 D.P., 1" face, are finished from the solid, no preliminary roughing being required. The Revacycle machine (Fig. 11) is primarily a high production machine which, in addition to speed has the further advantage of producing a gear having the localized type of tooth bearing.

The Revacycle process employs a circular cutter with blades which project radially outward from the cutter body. The cutter rotates in a horizontal plane and has a group of roughing blades followed by a group of finishing blades which are followed by a gap or space for indexing the gear blank. The blank is held motionless during the cut, while the rotating cutter is moved horizontally parallel to the root line of the gear being cut. The tooth shape is produced by the combined effect of the motions of the cutter and the shape of the cutter blades. This machine may be equipped with an automatic loading device which chucks the blank and removes the finished gear, the operator being required only to keep the loader magazine filled.

Straight bevel gears which are too large to cut on the generating type of gear cutters are cut on the form copying type of gear planer. Gears up to 192" in diameter may be cut by this process. The larger of this type of machines are called combination machines being equipped to cut spur gears as well as bevel.

In the form copying method of cutting, the blank is held stationary during the cut. After a tooth has been roughed or finished the blank is indexed for the next cut. The tool is carried on an arm which has a roller riding on a former or template secured to the frame of the machine. The tool has a reciprocating motion to cut the teeth for their full length and an infeed motion for cutting to the required depth. As the tool is fed into depth the roller rides on the template producing the required profile shape on the tooth.

Cutting Machines and Methods—Curved Teeth

Spiral bevel, Zerol, and hypoid gears are all cut on the same machines and with the same type of cutter. Two types of machines are in use; one using the rotating face mill type of cutter with multiple blades, the other, a planing generator using a single reciprocating tool. Spiral bevel, Zerol, and hypoid gears may be cut on both types of machines.

Gears up to 33" pitch diameter are cut on machines using the face mill type of cutter. Four sizes of generating machines cover this range of work using various sizes of cutters from 1.1" to 18" in diameter, the size of the cutter depending on the size of the gear to be cut and the machine on which it is used. Fig. 12 illustrates this type of machine.

In principle, the generating is similar to that used on straight bevel gear generators, the main difference being in the shape and action of the cutting tool. The rotating cutter is mounted on a cradle which rolls in a timed relationship with the work spindle on which the gear is mounted. The indexing of the blank to bring it into proper position for cutting the next tooth is usually accomplished during the return roll. The spiral angle and the hand of spiral are controlled by positioning the cutter relative to the work. When cutting hypoid pinions the work head is raised or lowered from the center position according to the amount of offset required.

A roughing cut and a finishing cut are usually required to cut a gear or pinion from a solid blank. Generally, the roughing cut is made on all the blanks after which the roughed blanks are chucked again for the finishing cut. Relatively flat gears are roughed without generation, using a straight infeed of the blank into the cutter. Pinions are always roughed using a generating roll as in finishing.

FIG. 10. Gleason 12" B straight bevel gear generator.

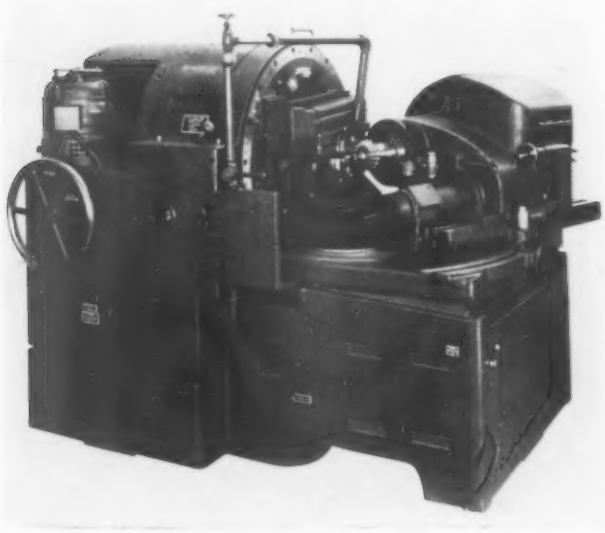
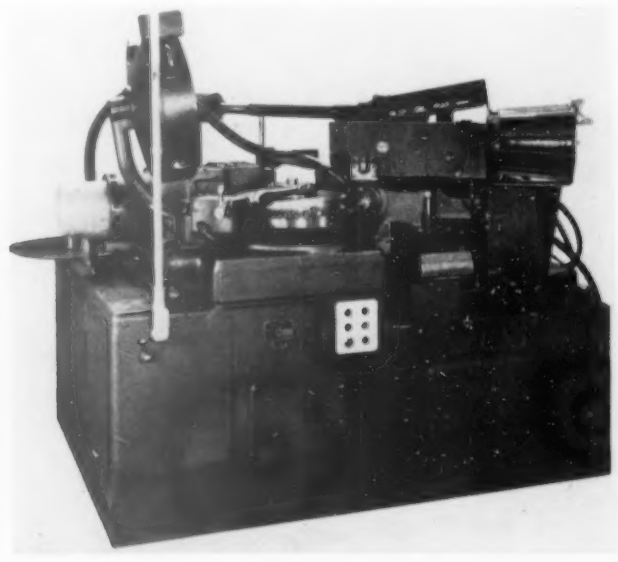


FIG. 11. Gleason No. 8 Revacycle Completing Machine.



Gears of fine pitch, approximately 12 D.P. and finer, even when of precision nature, are often finished in one cut from the solid blank. Relatively coarse pitches, often as coarse as 8 D.P., also are finished in one cut from the solid when quality requirements and the machinability of the material used permit.

All generators for the production of spiral bevel, Zerol and hypoid gears may be used for roughing purposes as well as finishing. However, when relatively large quantities of gears are to be produced it is economical from the standpoint of production time and equipment saving to use roughing machines specially built for roughing purposes.

For roughing pinions and gears which require roughing with generation, a rougher is used which will accommodate gears up to approximately 16" in diameter depending upon spiral angle and cone distance. The roughing is accurate, very little stock being left for finishing and very often pinions which are to have the teeth ground are roughed on this machine with no subsequent semi-finishing operation being required.

Gears which do not require roughing with generation, up to approximately 22" diameter, are roughed on special gear roughing machines which are designed primarily for the rapid roughing of relatively flat gears in production quantities. No generating motion is available on these machines, the teeth being formed by the shape of the cutter.

Machines which are built for finish cutting purposes only are used to great advantage when production quantities are large and when the specifications of the gear are such that the Formate shape of tooth can be adopted. These, being companion machines to the gear roughers, will also accommodate gears up to 22" diameter. The finish cutting on this type of machine is an extremely rapid operation. One tooth space is finished in each revolution of the cutter, consequently this method is known as the Gleason "Single Cycle" method. This is accomplished by the arrangement of the cutting blades in the head. Successive blades are set radially beyond the preceding blade in such a way that the cutter is in effect a circular broach. A gap between the first and the last blade is provided for indexing the work as each tooth space is completed. (See Fig. 13.) Thus it is not necessary for the cutter to be withdrawn from the cut, the timing being so arranged that indexing takes place when the gap is in line with the gear face.

The face mill form of cutters which are used in the production of spiral, Zerol and hypoid gears are made in two general types. Cutters up to 3½" diameter have the blades integral with the head, while larger cutters are of the inserted blade type. (See Fig. 14.)

Inserted blade cutters have individual blades bolted in slots on the periphery of the cutter head. The blade diameters may be altered as required by means of parallels of suitable thickness under the blades. The blades of finishing cutters may be adjusted radially to extreme accuracy by means of adjusting wedges under the parallels. This accuracy is essential to avoid cutter flats on the profiles of the teeth.

Several arrangements of the blades are used in both the inserted blade and the integral blade cutters depending on the cutting method used. Roughing cutters are always made with alternate inside and outside blades or cutting edges. Finishing cutters may have all inside, all outside, or alternate inside and outside blades according to the cutting method used.

To meet varying quality and economic considerations, several cutting methods have been developed for finishing the teeth of spiral, bevel, Zerol and hypoid gears. The following methods are those in general use. In each case, unless otherwise noted, it is presumed that the gear and pinion have been previously rough cut:

Spread-Blade Method is a method by which both sides of a tooth space are finished in one cut. The cutter must have alternate inside and outside blades which must be so arranged that the correct width of tooth space is produced. This method is generally applied to the gear member of a pair, the mating pinion being produced by separate cuts on each side of the tooth.

The Spread-Blade Method is used for cutting gears of conventional design in moderate and large quantity lots.

Fixed-Setting Method is used for high quality finish cutting of pinions. Different machine settings are required for each side of the pinion teeth. In high production two machines are used—one for each side of the pinion tooth. In moderate quantities one machine may be used by cutting one side of the tooth on all pinions after which the set-up is changed to cut the other side. The cutters used for the Fixed-Setting Method have all outside or all inside blades depending on the side of the tooth being finished.

Single-Side Method is used for cutting both the gear and pinion members when the quantities to be produced are small. One side of a tooth is cut at a time, the cutter being arranged with alternate inside and outside blades. Different cutter settings are required for opposite sides of the teeth.

FIG. 12. Gleason No. 26 Hypoid Generator.

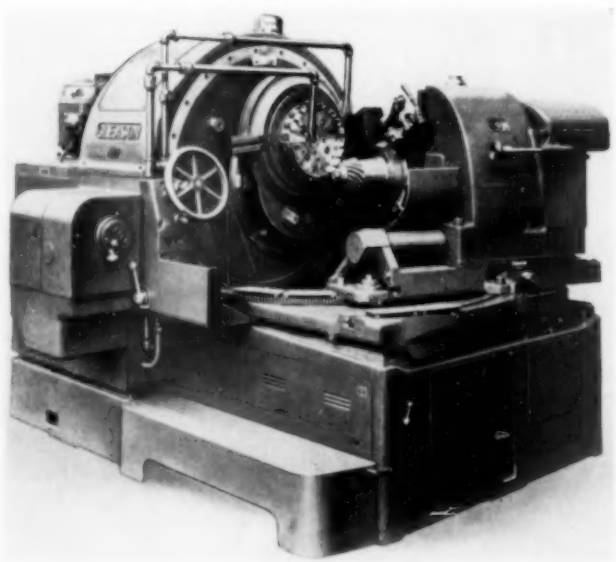
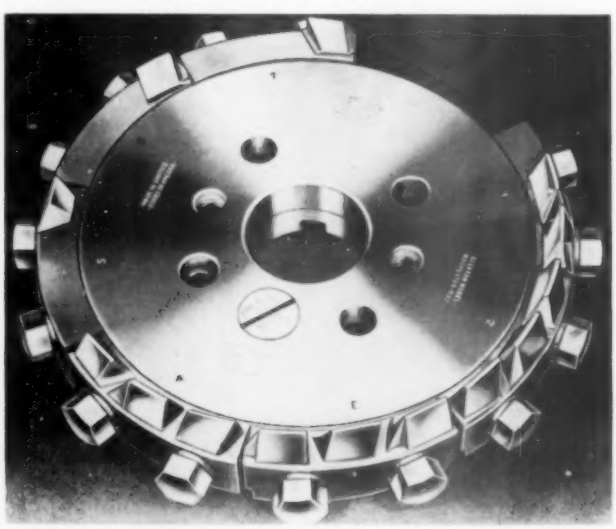


FIG. 13. Gleason Single Cycle finishing cutter.



Duplex Method is a spread blade method of finishing both sides of both gear and pinion members of a pair in one cut from the solid blank. It is limited to gears of fine pitch (12 DP and finer). Since both sides of the pinion teeth are finished with the same setting of the cutter, tooth bearing control is necessarily limited.

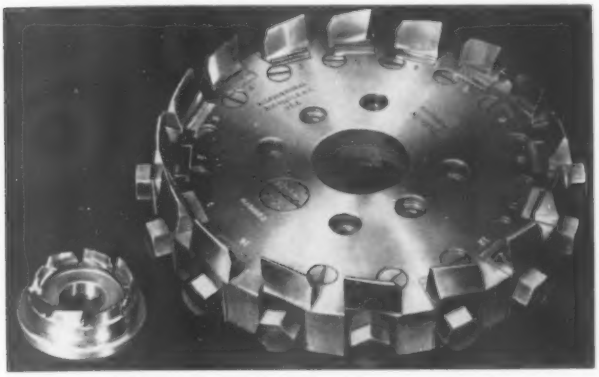


FIG. 14. Typical spiral bevel, hypoid and Zerol gear cutters.

Gleason Jobbing System is a simplified economical method for cutting miscellaneous gears and pinions of high quality in small quantities. By standardizing the pressure angle and spiral angle few cutters are required to cut gears and pinions of a wide variety. The gears are cut spread blade, the pinions one side at a time. This method can be used only on the Gleason No. 7 and No. 16 Generators.

Large Curved Tooth Gears

Spiral bevel, Zerol, and hypoid gears up to 100" diameter are cut on a planing type generator using a single reciprocating tool. The generation of the tooth profile is accomplished by means of a relative motion of the blank and the cradle carrying the tool slide. The indexing of the work is continuous and is in a timed relation with the stroke of the tool in such a way that the tool cuts on a different tooth at each stroke. Very accurate tooth spacing and uniformity of tooth profile are obtained through the use of this method.

The rough and finish cutting operations are performed on the same machine, but with a different tool. Several types of roughing tools are used, the type depending on the pitch. For pitches up to 2 D.P., a corrugated type of "V" tool is used for roughing the tooth space. This is followed by a semi-finish cut and a finish cut on each side of the tooth. Heavier pitches are first roughed with a slotting tool followed by a rough cut with a corrugated "V" tool.

END OF PART ONE. Mr. Hessler's article. PART TWO will follow in the February issue, THE TOOL ENGINEER.

Gear Shaving and Checking

By R. S. Drummond

THE AUTOMOTIVE INDUSTRY was first to recognize the need for silent gear trains, especially for transmissions, rear axle and timing gears. Following the pioneering in the automotive industry, other branches of industry became gear noise-conscious and silent gear trains began to be used on stationary power transmissions, speed reducers, Diesel engines, machine tools, and other equipment.

Several factors contribute to noise even in properly designed gears. Chief among these are errors in index, helical angle, tooth profile, eccentricity and rough tooth surfaces. Such errors not only cause noisy operation but limit the strength and, therefore, the service life of the gears.

FIRE DISTORTION

Comparatively few newly-cut gears have accurate tooth form and smooth tooth surfaces. Furthermore, the action of the hob or shaper tool cold works the surface metal of the teeth which results in unequal internal strains. In a recent investigation, for example, gears were selected from lots finished by different types of tools, different feeds, speeds, depth of cut and tool pressures. The result of this investigation showed a variation of several hundred per cent in the amount of cold work produced by the various machining methods considered. Of the gears in question, one sample which had been given a normal roughing cut showed seventeen "points" of distortion. When a similar sample, finished with a normal finishing cut, was examined, it showed only seven points because a great deal of the highly strained surface metal had been removed in the finishing operation. A third specimen, rough and finish cut and then given a final high speed shaving cut, showed only two points of distortion. Quite a difference!

R. S. Drummond **was graduated from Lehigh University in 1906. Later, joining the Gear Grinding Machinery Co., he spent 10 years in charge of manufacture and sales, then, in '29 organized the National Broach & Machine Co. Starting in the gear business in its infancy, Mr. Drummond has developed a number of modern methods of gear manufacture, including shaving, grinding and lapping. Author of numerous articles on gear processing, he has been a force in promoting the success of gearing.**

Any hobbing or shaping operation, rough or semifinish, leaves the surface metal work hardened, and this surface

"Red Ring" Model GCi-12" Heavy Duty Ultra Precision Gear Shaving Machine.

metal must be removed by very fine finishing cuts at a minimum tool pressure if fire distortion is to be conquered. When expensive, cold worked, gears are hardened, these strains are released and unpredictable distortion results: thus, the initial errors may be greatly increased.

Lapping such a gear, after hardening, may correct the accumulated errors, but, such errors may be of a magnitude to preclude the use of the lapping operation. If so, a costly, time-consuming grinding operation is necessary. And grinding is not only slow and costly, but the high temperatures generated at the point of wheel contact, regardless of the amount of coolant used, are very apt to cause microscopic cracks in the tooth surface.

A METHOD FOR CORRECTION

If tooth form, eccentricity, and tooth roughness are corrected in the "green" gear, and if the residual strains resulting from cold work are eliminated, fire distortion becomes practically predictable and may be compensated for. Thus, the gear as it comes out of the quench is highly accurate dimensionally and has good smooth tooth surfaces. As a rule, such gears, are quiet in operation.

That is the purpose of Rotary Crossed Axes Gear Shaving.* This is a metal cutting operation in gear tooth finishing which removes fine hair-like chips with very little pressure between cutter and gear tooth. Contact pressure and depth of cut are so small that cold work is avoided; thus, the superstressed surface metal left by the hob or shaper tool is removed and at the same time errors in tooth form and tooth roughness are corrected.

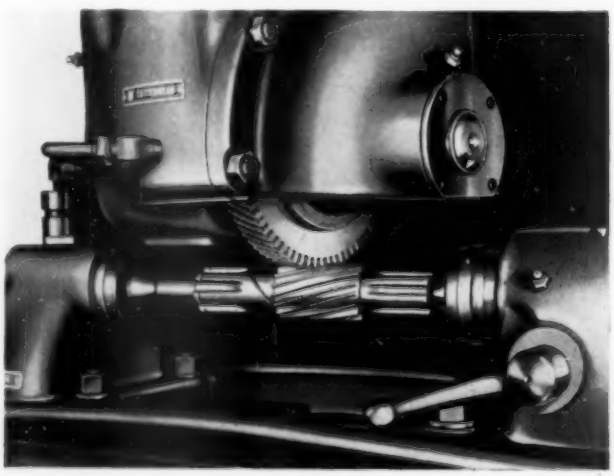
ROTARY CROSSED AXES GEAR SHAVING

In crossed axes shaving the work gear, or workpiece, is rotated under only slight pressure with a special cutter or tool in the form of a gashed helical gear, both the work gear and the cutter have different helical angles.

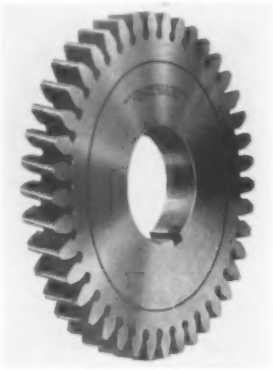
The angle made by their axes in the machine set-up is equal to the difference in their helical angles—normally from 10 to 15 degrees—although this range may be extended on both sides of the limits given. For open gears, the cutter is normally mounted with its center over the intersection of the axes of the two shafts, while for shoulder gear shaving the intersection of the two shafts is near the edge of the cutter. The cut caused by the crossed axes compensates for the variation in sliding action due to the involute roll. As gear and cutter tooth are brought together, cutting continues toward the pitch line up to the center point and in the reverse direction as they pass that point and separate. Thus, uniform cutting is assured over the entire tooth profile.

*In this paper, Red Ring Rotary Crossed Axes Gear Shaving equipment manufactured by the National Broach & Machine Company, is implied.

Shaving Spline Shaft on Red Ring Gear Shaving Machine.



Cutting can be rapidly increased by increasing the angle between the axes, but doing this tends to sacrifice guiding action as it reduces the width of the contact zone. Conversely, guiding action can be increased by reducing the angle between the axes, but this rapidly reduces the freedom of cutting until, at zero angle, cutting is replaced entirely by burnishing.



"Red Ring" Gear Shaving Cutter.

The real value in crossing the axes is the limiting of the contact pressure required in cutting and the accurate guiding of the cutting edges of the gashed tool. And, because it is essential that contact pressures be constant if one is to eliminate index or eccentricity errors, we have employed positive mechanical means, in preference to hydraulic, to insure pressure contact. Due to a certain flexibility of fluid systems, there is always the possibility that the cutter may ride up and down with the inequalities of the workpiece as it rotates. The profile of the work gear, its helix angle, index and eccentricity are determined solely by those corresponding elements of the gashed cutter and the machine being used. As in diamond boring, cutter speed is high (as much as 400 surface feet per minute) and feed fine, with the tool restricted to a small, definite zone contact. Thus, very little heat is generated—as evidenced by the color of the chips with practically no residual strains due to cold work. At the same time, no hair-line cracks in the tooth surface occur—and cracks are always conducive to fatigue failures.

THE GOVERNMENT CHANGES SPECIFICATIONS

Before the development of gear shaving, well-made machine tool gears were carburized, after being cut, then hardened and finish ground. It was, therefore, natural for the Government to specify that procedure for all gears used on Ordnance machines and other Government equipment.

When the gear shaving process appeared, the automotive industry—always alert for means to improve products or reduce the cost of making them—began to investigate this new method of gear finishing.

Several advantageous things about this shaving process were discovered which finally led to its adoption. First of all, it was considerably less expensive than grinding, and more accurate. It was also very much faster. It produced a tooth free from the characteristic grinding "flats" and it did not produce those microscopic heat cracks in the tooth surface which, ultimately, hasten fatigue failures in highly stressed gears. And these are important considerations, especially on truck and bus transmission gears. The shaving process also provided the automotive engineers with a way to finish cluster and shoulders gears, of varying diameter, and so closely positioned that practically, they cannot be ground.

In step with modern metallurgical and manufacturing methods, modern aircraft engine designers, have designed reduction units for minimum weight and maximum compactness, using cluster gears and light gears with thin webs —the worst possible type of construction for gears being carburized and hardened. And when war production started, the Government aircraft gear specifications were exactly as they had been for a long time. Gears had to be carburized, hardened and ground, and this included even the softer (not over 35 Rockwell C) oil pump gears.

One manufacturer of aircraft gears, however, had previously used the shaving and lapping process and got permission to *shave* and lap cluster gears, with the proper mechanics and tools in the heat treatments, distortion in these parts is held at a minimum and the necessary modifications made in the shaving tools to produce the desired results which could not practically be ground because of their close proximity. Next, this manufacturer applied the shaving process to other gears and proved beyond all reasonable doubt that the same tolerances could be held, by the shaving process, as by grinding and without the disadvantages of the latter. It happened, that there was a high percentage of rejections of ground gears, due to grinding cracks, and in the face of this irrefutable evidence, Government specifications for aircraft gears were changed to permit shaving. During the war, shaved gears were used for military aircraft, torpedoes, tanks, and trucks, detecting and sighting mechanisms, and ship propulsion gears.

THE ELLIPTOID GEAR TOOTH FORM

The teeth of a set of mating gears, as laid out on the drafting board, are represented by straight parallel lines or the ideal condition for operation—a condition, however, which is never attained in the actual machine assembly. Regardless of how carefully these gears are cut and heat treated, the mating teeth will not be parallel, except by accident and then only through a limited load range.

The actual contact of mating teeth is influenced by the characteristics of the gear housing, shafts, and bearings which support the gears, and by the characteristics of the gears themselves. Contact is also influenced by the accumulated dimensional errors of the gear teeth and all supporting elements, as well as by the necessary and accidental clearances in the supporting parts. Consequently, it is virtually impossible to achieve or maintain the parallelism of gear tooth contact visioned by the designer. If, by chance, perfect parallelism is achieved at some specific load it is entirely lost as soon as the load is changed because the curve of deflection of supporting parts is not a straight line. The result is that the operating load on a gear tooth, as conventionally designed, is usually concentrated at one end or the other where tooth strength is least and the tooth most vulnerable to failure.

The Elliptoid tooth has both its horizontal section and its vertical profile modified. A pitch line section through an accurately formed conventional spur gear tooth has sides that are designed straight and parallel. A similar section of an Elliptoid tooth shows these sides to be elliptical, thus leaving the tooth thinner at the ends than it is at the center or at the point where maximum thickness is desired.

Usually .0003" per inch of face width per side is sufficient. This is well within the customary allowable limits of good gear practice for the conventional tooth. In the Elliptoid tooth, however, end thickness is always less than it is at any other point along the tooth, thus providing a positive safeguard against end bearing.

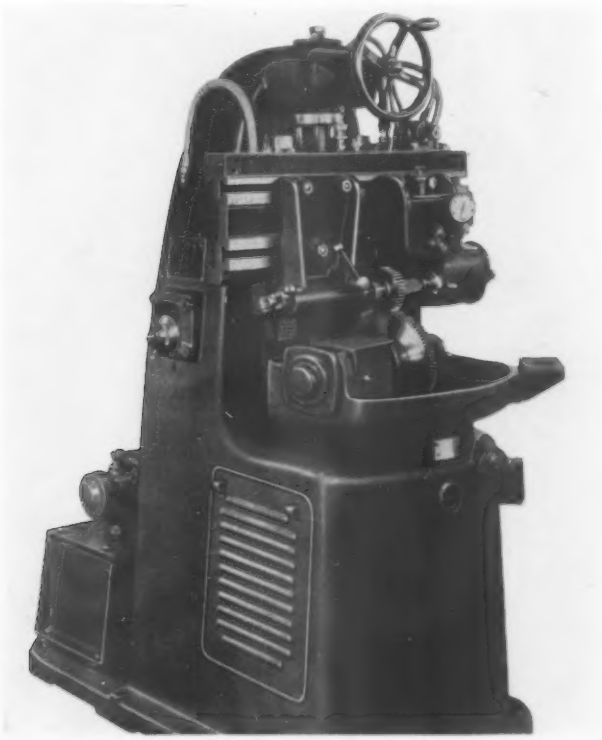
The Elliptoid tooth also has a vertical profile with a plus curvature of .0002" to .0003" at the pitch line to accommodate deflection and tip interference between mating gears. The involute at each end of the gear is modified by a fall-off or low curve to further avoid tip contact.

Where formerly an error of .0005" in parallelism—either right hand or left hand—was allowed in spur gears, it is now recognized that it is more important to have a plus curvature on the surface at the center of contact, thus avoiding end bearing. It has also been determined that, in normal transmission gears, a .0005" rounding of the face of the gear removes 95% of all possible end bearing.

PRODUCED ON THE SHAVING MACHINE

The Elliptoid tooth form is applicable to both spur and helical gears and is readily produced on Shaving Machines by rocking the work table as it is reciprocated. This rocking causes the cutter teeth to sink deeper into the work gear teeth at their ends than it does in the middle, thus thinning the teeth progressively toward their ends. Both the point of maximum tooth thickness and the amount of crown are readily controlled.

"Red Ring" Model GLG-8" Gear Lapping Machine.



"Red Ring" Lead Tester and Tooth Spacing Checker.

Another important use of shaving is the shaving of involute splines to attain high accuracy and exceptional finish. Even internal splines may be shaved if the inside diameter is sufficiently large. Finish shaving of splines eliminates the long costly grinding operation otherwise necessary where high accuracy and exceptional finish are required.

SOUND TESTING OF GEARS

We can never be sure that a pair of mating gears, when run together, will not produce objectionable noises until they are run under varying degrees of load. If they are installed in the final assembly and then prove too noisy, the assembly must be torn down and the gears corrected or a new set installed. That is a costly, time-consuming operation but one that may be avoided by testing for noise before the gears are assembled.

The Red Ring Gear Sound Tester, a very practical tool for both production shop and tool room, is built for the purpose of studying the operation of gear sets at various speeds and loads without other sound interference. It not only eliminates other sound interference but it concentrates and amplifies gear noise by reason of the specially designed accoustical sound box and horn. The amplification is approximately 50 times. Consequently, the Sound Tester may be used anywhere in a busy shop. No special soundproof room is needed.

The efficiency of this machine in excluding all other sounds is demonstrated by the ability of the inspector to hear the echo of the blood pulsations in his own ear when held to the mouth of the horn. The horn directs the whole volume of any sound within the test box directly to the inspector's ear.

Every gear set in operation has a characteristic tone and volume of sound. Some tones are more objectionable than others and volume covers a wide range; however, volume alone is not conclusive in an inspection of this kind. It's the combination of volume and tone that determines whether or not a pair of gears is satisfactory or not.

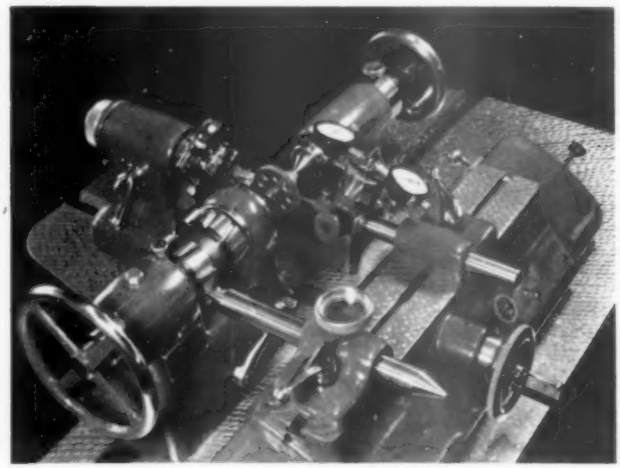
The experienced inspector can tell by the character of the sound produced by varying the load and speed of rotation what gear characteristics are in error. This test is, in effect, a quick diagnosis which saves much checking and experimenting.

"Red Ring" Model GSC-10" Gear Speeder.

CHECKING GEAR DIMENSIONS

No one will deny the necessity for some means of checking the dimensional characteristics of an important gear at intervals during production and before assembly. On high production operations, it is essential that dimensional checking be done quickly and accurately. And it is highly desirable that the checking instruments be such that semiskilled men be able to use them effectively.

In our belief, no other gear checking equipment so closely meets these specifications as does the Red Ring Universal Gear Checker. This unit is fundamentally simple, both in construction and operation. It is accurate without being delicate, and it retains its accuracy. It is easy to set up and fast in action. Any shop man familiar with gears can handle it.



"Red Ring" Combination Lead Comparator and Gear Tester.

Essentially, the Universal Gear Checker consists of a heavily-ribbed surface plate table finished to the accuracy of a toolmaker's flat with two acurately aligned slots at right angles; a head- and tailstock for holding the work gear, and one or more measuring heads.

Head- and tailstock occupy the transverse slot on the table, and can be moved laterally within the capacity of the machine for work of various lengths. The slot at right angles to this is used for the measuring heads, the head being positioned according to the diameter of the gear being checked.

The axis of each measuring head spindle is parallel with the table surface and in the plane of the axis of head- and tailstock centers. There are two basic measuring heads, one for index error and the other for errors in helical angle, wobble, eccentricity and tooth parallelism, others for additional measurements.

The instrument above described, by using the several heads provided, checks index, helix angle and wobble, eccentricity, tooth size and lead of spur and helical gears. It also checks parallelism of spur gear teeth and splines, and the amount of crown on Elliptoid teeth, both spur and helical. Another instrument is available which checks index and eccentricity of internal gears.

End of first installment. This Symposium on Gears will be continued in the February issue, the TOOL ENGINEER.

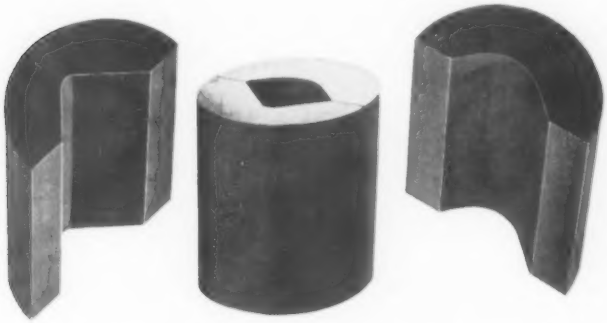
By Filip Stad

Sectional Carbide Nibs

New method provides for higher mold pressures and effects marked operating economies

As RECENTLY established after six years of experiments into the branch of powder metallurgy, at Firth-Sterling Steel Company, McKeesport, Pa., production records achieved by sintered carbide tools may now be duplicated by sectional carbide nib molds. Firth-Sterling, said to be the largest producer to date in this country of such preformed nibs, also produces the steel casings and shanks for the molds and plungers. Carbide Die & Mold Co., Pittsburgh, is the first and only reported fabricator of the finished nibs and molds.

William J. Loach, superintendent of sintered metals at Firth-Sterling, who has compiled the results achieved by the revolutionary new molds in test installations operating in a group of key industrial plants, affirms that the sectional nibs have produced *per grind* from seven to ten times the number of compresses possible with steel molds. They are said to have equalled or surpassed the production of solid carbide nib molds, and, in addition, may be recut, with the production after each re-cutting being equal to the production of the original mold.



Preformed sectional sintered carbide nibs originated by Firth-Sterling Steel Company.

In announcing the commercial availability of such molds, Mr. Loach specifically cited the case history of a plant engaged in pressing tungsten-silver electrical contacts. The tool steel molds, originally used, operated in connection with hydraulic presses exerting a pressure of 40 tons p.s.i. When this set-up proved inadequate to produce points tense enough to reduce burning, and when such molds had to be discarded after 12,000 or fewer compresses, it was decided to shift to sectional carbide nibs and carbide-tipped plunger. Simultaneously, the manufacturer stepped up the pressure from 40 tons to 60 tons, then, to an unprecedented 70 tons.

Hand lapping the mold with diamond powder.

After 27,000 compresses had been achieved with the new set-up, the copper brazing holding the carbide tip to the steel plunger failed. With a redesigned plunger of solid carbide, shrink-fitted into the steel shank, the mold continued in service from 27,000 to 124,000 units, at which time it was examined. Wear was less than .001 inch. The plunger was then redressed, .008 inch being removed from its head.

Noting that the mold had worn less than .001 inch, and that the tolerance permitted on these electrical contacts is .005 inch, the engineer on the job estimated that the mold should be good for 500,000 compresses before re-cutting would become necessary, and since the estimated number of re-cuts based on the amount of carbide stock in the nibs, is reported to be five, a production of 2,500,000 units may be expected during the complete life of the mold.

Regular operating test runs of the new type molds, in other plants, indicate production runs of 500,000 pieces per cut, with ten to twelve re-cuts apparently practical in many instances. As the re-cutting has proved to be not only practical but economical, specifications governing the amount of stock in the original sintered carbide nibs in such molds is determined by the anticipated production.

Fitting plunger to the mold. Tolerance is .0003 on each side.

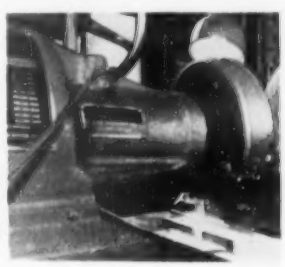
The sectional nibs in existence are made of Firthite of a hardness determined by the metal powder to be compressed. The test applications to date have covered the following powdered metals: carbon, brass, bronze, copper, iron, tungsten, and tungsten-silver. A substantial number of the new type molds also are being used in connection with pellet presses for compressing pharmaceutical powders.

Decision of Firth-Sterling to shift from solid to sectional nibs followed the persistent observation that a sharp corner in a solid nib, subjected to load doubles, triples or further multiplies the stress depending upon the angle and sharpness of the corners. Under repeated stress, high local stresses at the corners caused fatigue failure by cracking and chipping. Re-cutting of solid nibs was only possible by hand, which was impractical. By comparison, the lapped seams in the sectional nibs achieved "controlled" cracks comparatively free of trouble and insuring full life for the mold, and it is believed that sectional nibs will eventually make it possible for the user to finish his own molds.

Checking the mold with gages.

Besides, a sectional nib mold also may be re-cut to larger size within the limits of the nib diameter. This salvaging of materials, combined with savings in the re-cutting process, reduces over-all mold costs to about two-thirds of the original cost.

Photos by Courtesy of Firth-Sterling Steel Co., McKeesport, Pa.



Grinding of the sectional nib to exact size is done with a diamond wheel on a surface grinder.

The $64 Question:

In which your knotty problems are referred to 19,000 reader "consultants"

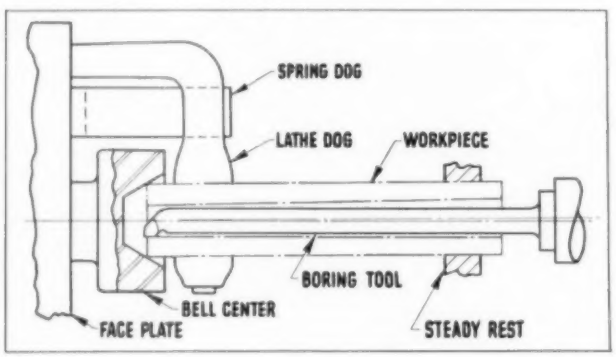
The Answers:

The following answers are in response to a question, by Walter Dimitruk, which appeared in November issue, THE TOOL ENGINEER.

Technical Editor, THE TOOL ENGINEER:

I . . . submit an answer to the question by Mr. Dimitruk. He states: "Is there any other way, without reaming with a tapered reamer . . ., of getting a tapered hole 7" long as per sketch, .500 dia. on small end and .800 on large end. He . . . states that the compound slide of an ordinary lathe is too short for boring a tapered hole that long. The method proposed must be inexpensive."

For my solution no special tools are needed. I would chuck the piece in a lathe, holding it not more than ⅛" at the end, with a steady-rest at the other end for support. I would bore a .500 hole clear through with a boring tool mounted firmly on the carriage. The tool should be left set in that position, when I would move the steady-rest away from me until that end had been moved exactly .150. This would be accomplished in three or four easy cuts. Finished cut will leave a tapered hole .800 at one end and .500 at the other.



Carl E. Askerbloom
Hartford Chapter, A.S.T.E.

A similar solution is offered by Walter Binder, Detroit Chapter, who illustrates his answer. He says: "In regard to question . . . drill a 7/16 hole with the part on center, then set off center and run through with bit on an ordinary lathe."

And, another:

Dear Sir:

With regard to Mr. Dimitruk's question . . . here are two answers:

1. Loosen headstock hold-down bolts and raise headstock from Vee way, onto parallels. Slew head around to correct angle by indicating a sine bar, and proceed to bore hole as you would a straight one.

2. Step drill hole with several drills to remove greater part of stock. Turn a piece of drill rod to correct taper, cut a couple of grooves in it, back it off with an air grinder, harden, draw and ream hole.

George Hull
Detroit Chapter, A.S.T.E.

And, terse but pat:

Bore hole using standard taper attachment on engine or turret lathe.

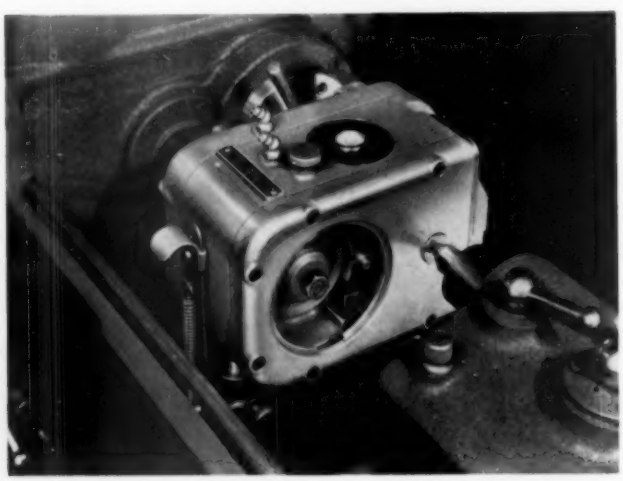
A. Ketelsen
Los Angeles Chapter, A.S.T.E.

Contributed

Semi-Automatic Diamond Dresser

MANY SINGLE point thread grinders can now be converted to multi-ribbed wheel work by means of a new Semi-Automatic Diamond Dresser made by The Sheffield Corporation of Dayton, Ohio.

The advantage of having more than one rib on a grinding wheel has long been recognized but the dressing problem has prevented its widespread usage. In single point or single rib grinding, the one rib must bear the entire load, whereas the load is divided among all the ribs of the multi-grooved wheel. Therefore, the ribs retain their form longer, less frequent wheel dressing is required and more parts can be produced per dressing.



The difference between the two types of grinding wheels, from the standpoint of faster production, can be visualized by comparing their effective grinding surfaces. The single rib of a 13" diameter wheel has an effective surface 49.8" long. The same diameter wheel, with a ½" face, may have as many as 10 ribs of a 20 pitch thread formed upon it. The effective grinding surface would therefore be 408.5 lineal inches of thread form.

The Sheffield dresser is mounted between centers of the grinder and is actuated by the driving pin on the face plate. A precision ground cam, for the required pitch, is mounted upon an accurately ground and lapped spindle and controls the movement of a suitable diamond. The reciprocating movement of the diamond, in conjunction with the uniform lateral motion imparted by the leadscrew, results in the desired wheel profiling action.

Induction Heating for Brazing*

A RECENT INSTALLATION of Induction Heating at the Reed Roller Bit Company of Houston, Texas, brazes alloy tool tips onto single point tools in a fraction of the time formerly required with acetylene gas torches. A great number of tools are required at the plant, where product stock hardness is approximately 350 Brinnell and the tools break or dull from wear. With acetylene brazing, the tool tip was overheated and several minutes were required to braze each piece. They can now be brazed on a 1½" x 1½" tool—the largest used—in about 30 seconds using induction heating. Not only is brazing speeded up, but tool life is improved since the carbide tip and the soft steel shank are heated at different rates and the tip does not reach the same temperature as the shank.

Brazing tips to single point tool shanks and removing of those that have been dulled by wear is done in thirty seconds or less with a standard 10KW, 450KC R.F. generator. Joining is done on a production basis since it is necessary to sort the various sizes of shanks.

This is because power input, to a magnetic material, is much greater than to a non-magnetic material with the same flux density. Most of the heat put into the carbide tip is by conduction from the steel tool through the silver solder.

As only about one inch of the tool is in the coil, all of the power is concentrated in a small volume in a very short time. This brings the shank temperature to about 1400°F in 30 seconds or less on one end, leaving the other end cool enough to handle with the bare hands.

The work coil for this job was designed to handle several sizes of tools without adjusting the R. F. Generator or changing the work coils. This was accomplished by designing two coils, one consisting of six turns of one-eighth inch copper tubing 2" x 2" on the inside square, and connecting them in series. With both of these coils connected to the generator in series, all sizes of tools could be heated, this method enabling the operator to handle several sizes of tools without first sorting them by sizes.

A safety feature of the Tuned Plate-Coupled Grid oscillator circuit used in the generator is the grounding of one side of the work coil, thus putting it at a comparatively low voltage above ground. This is possible since most of the voltage is across the tank coil. The R. F. Generator used is a standard ten kilowatt, 450 kilocycle set, with power supply 440 volts, 3 phase, 60 cycle. Control is by means of a "start-stop" button mounted on the face of the cabinet.

After installation and tune up, an inexperienced operator had no difficulty working with the generator and was soon very proficient in its use, both for brazing on new tips and removing those dulled by wear. As a result, the plant has experienced no tool shortage and one bottleneck in production was broken.

*Condensed from a paper by T. A. Vernor and E. F. Adams, Westinghouse Electric Corporation, Houston, Texas.

Contributed

Spectacular Results with Cemented Carbide Bearings

SLEEVE-TYPE BEARINGS, made of solid cemented carbide running against solid cemented carbide in place of the standard ball bearings, on Dumore "toolpost" grinders made it possible for Carboloy Company, Inc., Detroit, to use these grinders under what, ordinarily, would have been heavy overloads for the steel bearings. Under these conditions, the Carboloy bearings not only virtually eliminated all maintenance but resulted in a fifty-fold increased bearing life.

The grinders are used at the Carboloy plant for the production grinding of internal and external surfaces of carbide die nibs. Diamond wheels are used, and the necessary wheel pressure is about ten times that used with ordinary abrasive wheels. This resulted in considerable overload on the standard ball bearings of the Dumore spindle, which ran accurately for about a week and then showed signs of wear. The shaft developed play which rapidly grew worse until the machines had to be shut down and new ball bearings installed.

To overcome this, a set of Carboloy cemented carbide combination thrust and radial load sleeve bearings, with conical bearing surfaces was installed at each end of the shaft. The inner half of the bearing—of Grade 44A Carboloy which is widely used for drill jig bushings, lathe centers, etc. —is attached to the shaft with Woodruff keys. The surfaces of these inner bearing members are grooved for lubrication.

The stationary outer bearing members are of Grade 78B Carboloy, which is particularly tough as well as wear resistant. The conical bearing surfaces take the bearing load, while the cylindrical portions may have a running clearance of from 0.0005" to 0.0008". Bearing surfaces are lubricated with a mixture of kerosene and collodial graphite, which is applied by putting a few drops into a small cup. The lubricant reaches the bearings through wicks.

Subjected to the same service as the conventional bearings (continuous operation throughout two eight-hour shifts per day) the carbide to carbide bearings have been in operation for more than two years, with only about 0.00004" of wear in that time. Thus, it is estimated that under such conditions they will outlast the hardened steel ball bearings more than 50 to 1. Only four-millionths of an inch wear in two years' service has occurred under conditions which caused standard ball bearings to wear out in a week or two.

By Guy M. Shingle-decker

Stamping Electrical Steels

Precision in both presses and dies essential to securing long die life and accuracy in producing motor and transformer laminations

The stamping of electric steel laminations has been a perennial "headache" in mass production. Because of their nature as abrasives — these steels have been particularly severe on dies. In view of this, methods and dies developed by Allegheny-Ludlum Steel Corporation should be of especial interest to all who are engaged in the processing of these steels.

Ed.

A PRODUCT can be no better than the tools used to make it.

Experience gained in the production of electrical steel laminations for use in motors and transformers indicates that this maxim is particularly applicable to stamping this unusual type of steel.

While the customer is primarily interested in magnetic performance and accuracy in dimensions, many factors must be watched in order to obtain the desired degree of performance. The first step, of course, is the selection of the proper type of steel. This involves deciding not only on the material, which after annealing will have the desired electrical characteristics, but on the steel that will have satisfactory stamping qualities for economical production, and in most cases, upon a steel which may have its electrical characteristics improved by annealing subsequent to stamping.

From the standpoint of the producer of the laminations, the major factors are minimum scrap loss and long die life. Dies are expensive and their life often is uncertain so that this is not only a major consideration to the producer, but may be a highly variable factor in estimating costs of any type of production requiring large numbers of laminations.

A die which costs $5,000 represents a cost of only 1/10 of a cent per piece if it lasts for 5,000,000 pieces. But if the die fails at half a million pieces, the die cost is 1c per piece—10 times as much.

The experience of Allegheny Ludlum in the field of achieving long die life and accuracy is of particular interest due to the fact that, in addition to producing the specialized steel needed in this field, it also produces laminations made from its own electrical sheet and strip from dies which are made from its own tool steel. A factor of special interest to readers of THE TOOL ENGINEER is that after the right electrical steels and the right tool steels for the dies are selected, the design and accuracy of the presses and the dies become vital to production costs.

***Guy M. Shingledecker*, Manager of the Fabrication Division of the Allegheny Ludlum Steel Corporation, Brackenridge, Pa., has been active in this division for the past fifteen years. Previously, for many years, he was connected with the manufacture of the company's various steels. He is a member of Pittsburgh Chapter, the A.S.T.E.**

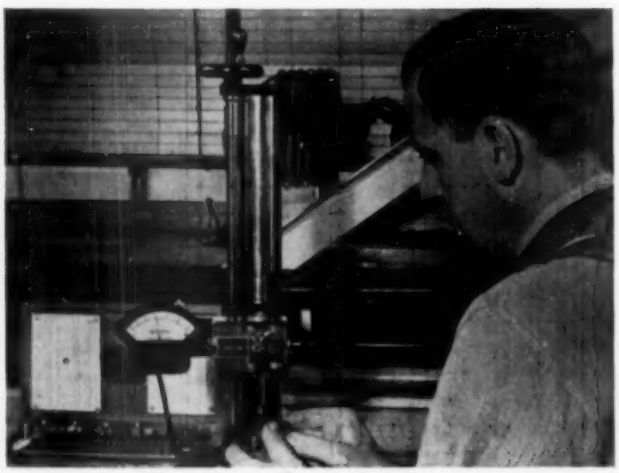
Since minimum burr height, as well as accuracy in dimensions, is essential to the customer, great care must be used in the determination of clearances between punches and dies. A slight variation in thickness or hardness of material being used can make material satisfactorily workable or unworkable with a given die clearance. This makes it essential, once the type of material has been selected, that punches and dies be made within close tolerances in order to produce stampings with a minimum burr and thus reduce rejections. An accuracy of plus or minus .0001 inches is the tolerance used on most types of dies as made in the Allegheny Ludlum shop.

The following clearances on each side of punches are recommended for various types of electrical steel:

Grade of Steel	No. 29 *Gauge*	No. 26 *Gauge*	No. 24 *Gauge*	No. 22 *Gauge*
Transformer Grades	.0007"	.00085"	.0010"	
Dynamo Special	.0007"	.00085"	.0010"	
Dynamo	.0006"	.00075"	.0009"	
Electrical	.0005"	.00075"	.0009"	.0015"
Armature	.0005"	.00065"	.0008"	.0015"

BELOW. Checking with an electro-limit gage, the measurements of "pie-sections" for a sectional type die.

RIGHT. One of many storage racks for Allegheny Ludlum laminations dies.



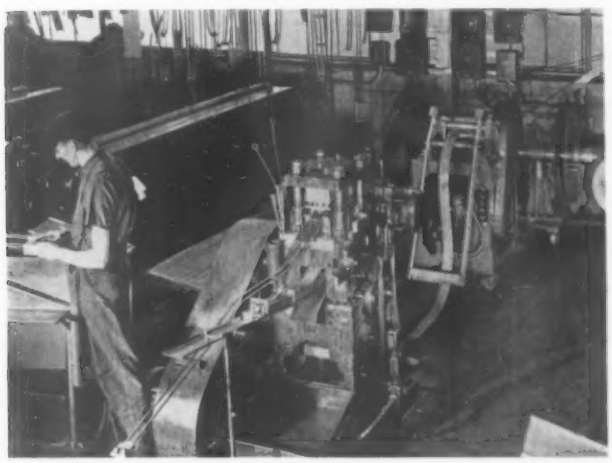
For lowest die costs per pound of finished laminations, it has been found desirable to maintain the following burr inspection limits as a basis of the best die grinding practice.

Gauge	*Burr Limit*
No. 29	.002"
No. 26	.0025"
No. 24	.003"
No. 22	.0035"

This procedure will result in less die steel removal per grind and the longest possible die life, while producing the highest quality of magnetic core laminations.

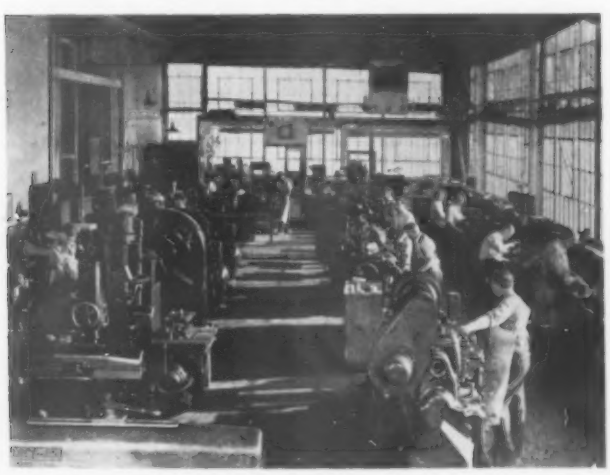
The great loss involved in the breaking of a solid die, which requires the building of an entirely new unit has been responsible for the adoption of the practice of using dies built up in sections. The complex geometry of some of the parts to be fabricated also make it necessary that some dies be built in sections in order to facilitate grinding.

Under the system of using sectional dies, any breakage may be repaired by the insertion of a new section without the necessity of making an entirely new die. Spare parts for extremely complex sections can be made in advance and stocked so that the damage to any die can be repaired in a minimum of time. The building of such dies obviously is costly, but the savings resulting from the ability to repair damaged dies makes the initial cost worth while.



ABOVE. Standard 25 Ton Press for producing transformer laminations (E & I Type) from alloy coil. Die is sectional progressive style, using Huron Die Steel on all cutting edges—hardened to 62-64 Rockwell "C" to resist wear.

BELOW. A section of the Allegheny Ludlum tool room where soft operations are performed in the construction of sectional dies. Following cutting off, shaping, milling, drilling and bench work, die sections move to the hardening room, thence to the grinding room where the intricate die assemblies receive the final touches of precision.



The production of sectional dies requires a tool department with the finest equipment and with tool makers trained to work to extremely close tolerances. The close tolerances necessary to produce parts sufficiently exact cannot be achieved by ordinary grinding equipment. The practice in the tool room of the Allegheny Ludlum die shop is to buy the best equipment available and in most cases recondition the machine before putting it into operation. This rebuilding involves painstaking hand scraping of ways and special fitting of all bearings to a degree of accuracy necessary to turn out work with tolerances of plus or minus .0001 inches.

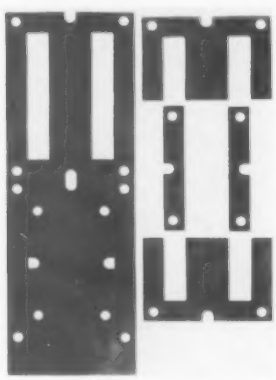
In addition to the usual gauges and instruments, optical comparators are required giving a magnification of 50 to one in order to check complex die contours.

Most of the grinding machines are provided with magnetic chucks, and magnetic jigs are used for positioning parts which must be ground to special angles.

Since the best die, punching a steel with ideal stamping qualities, can be ruined on a defective press, special care must be given to press room equipment. The best presses available are used. Allegheny Ludlum follows a practice in relation to its presses similar to that on its grinding equipment. When a new press is bought, it usually is torn down and rebuilt. Some parts are chromium plated to minimize wear and all bearings are specially fitted to insure perfect accuracy and long life.

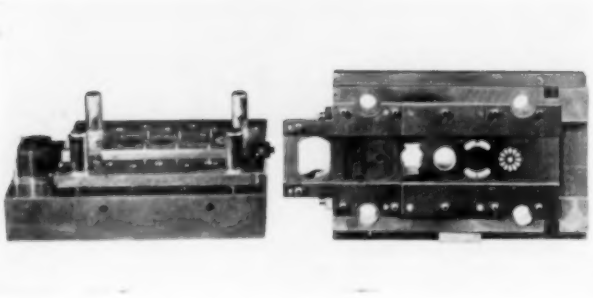
A systematic program of inspection and maintenance is followed on all press equipment. This keeps a crew of maintenance men constantly busy checking and repairing the presses.

Progressive dies are used for most jobs. These dies consist of a number of stations where such punching operations as piercing, allotting and blanking are performed in sequence. In the case of a typical rotor and stator die, the sequence is as follows: Pierce rotor, blank rotor and trim air gap, slot stator, and blank stator. This type of die produces laminations suitable for automatic stacking and perfect alignment from the press which saves labor and money in comparison to the compound method.



LEFT. Stages in making "no scrap" transformer laminations. Coiled strip is exact width of finished laminations. In first operation holes are punched; in second "I" sections are blanked; in third "E" sections are blanked.

BELOW. Apparatus developed by Allegheny Ludlum for measuring core loss and exciting current, in testing stator laminations.



The complex structure of a typical sectional 4-stage progressive laminations die, for operation in high-speed automatic presses. Sectional construction of dies calls for exacting workmanship, but adds to die life and maintenance of production by permitting quick replacement of one or several "Die-sections" in case failure occurs.

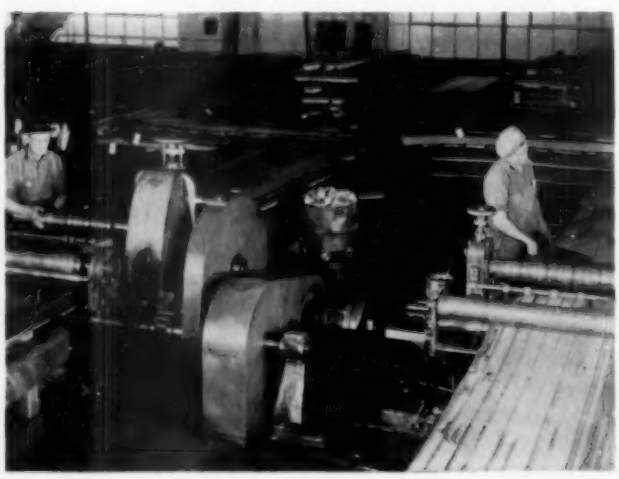
One interesting operation is the production of "No scrap" transformer laminations. These usually consist of "E" and "I" shapes. They are designed to secure both maximum material economy and electrical performance. The only loss in the material is due to the holes and the best electrical performance is obtained by having most of the section in the direction of rolling.

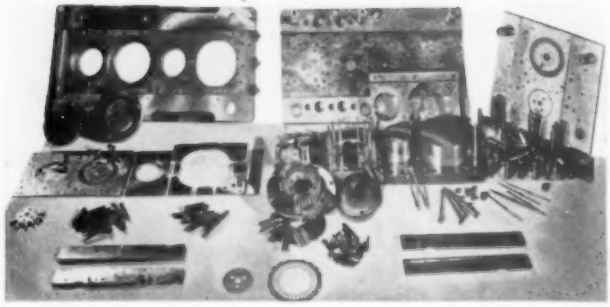
The holes are punched from the strip at the first station. The "I" pieces are then blanked out forming the windows of the "E" pieces. The "E" pieces are then blanked. Two "E" and two "I" pieces are produced with each stroke of the press. It is pertinent to note that the economy in material is effected by making the length of the "I" pieces twice the length of the "E" windows. After punching, the laminations are inspected, stacked and wired together in preparation for annealing. Annealing of most types of steel is performed in electric furnaces under controlled atmospheres. Proper temperature recording equipment is essential for correct annealing.

The annealing of high permeability nickel alloys is conducted under dry hydrogen at high temperatures and with the use of suitable inert material between the laminations to keep them from fusing together. Equipment and control of this annealing process are so complex and delicate that the company recommends that users of this type of steel for stamping do not attempt annealing themselves, but return the laminations to them for annealing.

The department has extensive facilities for testing stacks of laminations in order to determine the magnetic performance of the core material. In making tests, the laminations

Rotary shear, slitting electrical sheet material to specified width for the die. Slitting accuracy guaranteed within .005 inch, is absolutely necessary in fabricating scrapless laminations, where the width of the strip is the width of the laminations.





4-stage progressive sectional lamination die, partly disassembled, showing the hundreds of accurately ground parts.

are assembled into finished cores as near as possible to the conditions of actual use, placed in windings similar to those used in the final assembly, and the performance checked.

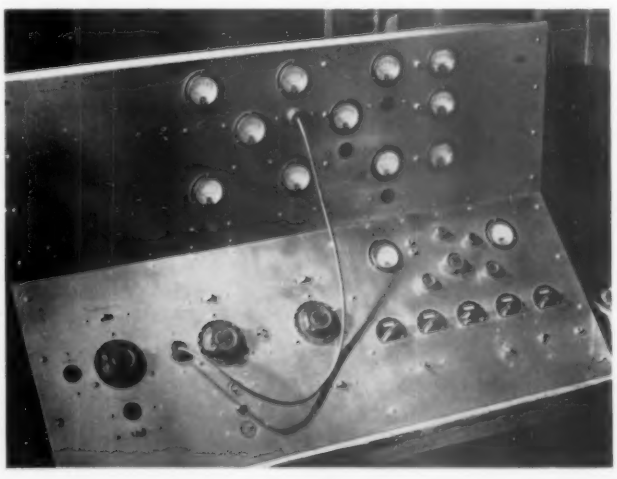
The result of the policy of accuracy and control throughout the entire process has permitted the organization to achieve, not only some outstanding individual records in the life of dies, but also an excellent average record. Die life is predicted in the majority of cases on the thickness of die sections of 1.250 inches. This thickness can now be almost entirely utilized. As the section is ground and the thickness is reduced, the induced stresses due to compression and impact become greater and greater until the section fails. Thickness at which failure occurs depends on the simplicity or complexity of the shape of the lamination.

There have been cases where failure occurred at .046 inches and other cases where this figure has been greatly exceeded. In some instances the die never failed but was ground down so thin that the threads in the screw holes became insufficient to hold the die plate in the shoe.

Since maximum production is a function of the utilization of die life and since maximum economy is a function of production, the importance of die life is obvious. Therefore, the aim of die engineering is to develop designs which integrate all factors affecting die life. One outstanding die produced 41,000,000 pieces on a die life of only 1.095 inches.

An important consideration in the production of lamination is that, in 90% of the applications, correct annealing of the lamination, after stamping, is essential in order to secure to the desired characteristics. Correct and carefully controlled annealing often can save money by permitting the use of lower cost steel than otherwise would be necessary. Consultation with the users' engineers is advisable in order to select the most economical material for the job.

Testing apparatus used in measuring permeability and core loss characteristics of transformer or motor cores. Tests are run on all laminations produced.



By Karl Stad

Unique Grinding Attachment for Circularity Relief

Novel Application of Known Principle Greatly Widens Use of Universal Cutter Grinders

OF RATHER universal interest, in view of its broad application, is a new device for radial relief grinding of various shapes of reamers and cutting tools. The device, which was developed as an accessory to any universal cutter grinder under the direction of R. W. Andreasson* of Detroit Reamer & Tool Company, has been tested during several years of intensive war production and is now available to industry. It is being manufactured and marketed by the Lawson-Leschke Company, 110 East 6th St., Royal Oak, Michigan, to whom the inventor assigned manufacturing rights.

With this attachment, it is possible to grind radial relief diameters or forms with a minimum of land or with a sharp edge, as desired. The unit consists of a motor driven headstock furnished with an adapter for collet work, such as center drills, taps and straight shank counterbores and similar tools. A tailstock is provided for grinding work between centers.

Actually, work is ground between dead centers, which provides for true diameter in any type of work. And that is where the novelty of the attachment comes in, for the centers advance and recede with each revolution of the spindle. With the table at right angles to the spindle, and the attachment set at an angle, this means that a radial relief is in effect, for each revolution, in direct ratio to the angular setting of the attachment. And if, coincidentally, the grinder table should be set at a slight angle, a back taper or clearance is effected simultaneously with the back-off. That is, the tool can be ground straight or with back taper, as desired, and this action will be uniform throughout the length of the grind.

**A.S.T.E. Member. See also Back-off Method for Fluted Cutting Tools, and Speed and Precision with Hyper Drilling, in March and July issues, respectively,* THE TOOL ENGINEER.

In other words, the centers move forward (toward the tailstock) and inward toward the wheel at the same time. This gives radial clearance or circular relief. Where work cannot be held between centers, the collet chuck provides the same forward and inward motion. This motion is effected by a "cam" which, in a strict sense, is not a cam at all but a disk provided with an annular drop, the depth of which governs the advance and recession of the centers or chuck, whichever is used.

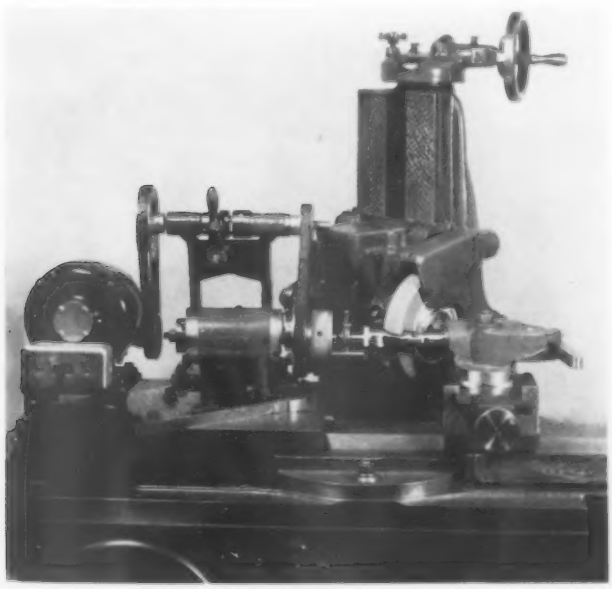
The action is unique and, although simple in principle and operation, does not lend itself readily to verbal description. However, it is quite clearly shown in the photograph, and this, with the descriptive caption, gives a clear picture of its operation.

A feature of the device is that, whether one wants .100" clearance, or only .0005", it is not necessary to change the cam. It is only necessary to swing the headstock and tailstock to greater or lesser angle and this will provide the clearance desired. However, clearance is very important in most cutting tools—in fact, is quite essential in order to produce a smooth cut.

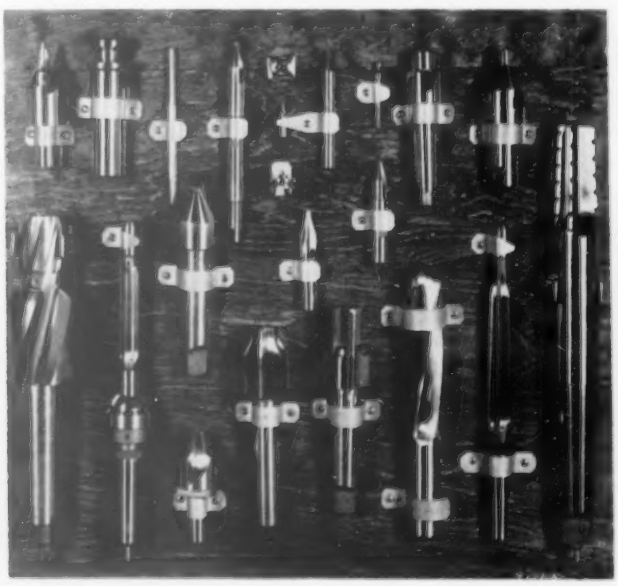
In this connection, it is claimed that tools ground by this method have shown a very considerable increase in tool life —up to 80 per cent—with coincidental increase in production and improved product quality. After due consideration of tools so processed, these claims appear to be entirely reasonable.

While originally designed for a universal grinder, where tools can be dressed to different form and shapes, the attachment will fit any type of external grinder. And, if it is not to be used for circularity relief, it is only necessary to set the head and tailstock to zero, when both may be used as regular centers.

Radial relief grinding device mounted upon the table of a universal cutter grinder.



Typical examples of tools relieved by means of the attachment shown at left.



By Sherman B. Hagberg and Leo F. Smith

The Place of Cooperative Work

College Training, Plus Practical Experience, Initiates Students into the "Know-How" of Manufacture

Introduction

WITHIN THE PAST few years there have been a number of criticisms made of engineering education. Some of the comments made by industrial executives have been: (1) not enough time has been devoted to the social sciences and problems of human relations; (2) the training received by graduates does not equip them to deal with problems of labor and management; and, (3) engineering courses have been too theoretical. Undoubtedly, some of these criticisms are just, and, although engineering educators are alert to the need for improving their programs, the solutions are not easy to find.

In a former article[1] procedures were outlined for applying engineering principles to the design of the courses of study so that much superfluous material might be eliminated. It is the purpose of this article to point out the function of cooperative work[2] in a tool engineering curriculum, and to illustrate how the provision of this type of experience enables the students to acquire some understanding of the problems of labor and management and a keener insight into the theories studied in school. Actual plans, which have already been made for assuring a coordinated sequence of training between the cooperative job and the tool engineering curriculum, will also be described.

Sherman B. Hagberg **was graduated from the Rochester Institute of Technology in 1933, and was subsequently appointed Instructor in the Mechanical Dept., R. I. T. He is a member of Rochester Chapter A.S.T.E. and author of a book,** ***Machine Shop Practice,*** **published by Harper & Bros. Mr. Hagberg is a strong advocate for the inclusion of tool engineering courses in our colleges.**

The Function of Cooperative Work Experience

Cooperative work, as an essential part of engineering education, was first initiated at the University of Cincinnati by the late Dean Herman Schneider in 1906. Even in those early days practical men were severe in their criticisms of engineering graduates. At that time the old apprenticeship system had broken down and it appeared as though engineering colleges were making little effort to provide the connecting link between theory and practice. The story goes that a solution of this perplexing problem occurred to Dean Schneider in the following manner:

"One evening as he was walking across the campus of an eastern university where he was teaching, he heard the answer in the blast of a Bessemer furnace at a neighboring steel plant. Instantly, the idea appealed to him as something perfectly simple and obvious. Here was something better than any conceivable school shop—a million dollar laboratory with unlimited possibilities for illustrating the applications of technical theory. In this plant many graduates of this same college would find employment, as others had before them. Why should they not learn as students to translate their book knowledge into terms of industrial processes?"[3]

Leo F. Smith, **acting chairman, Educational Research Office and Director of Counseling Center, Rochester Institute of Technology, received his A.B. from Occidental College. In 1942-43, he received degrees M.A. and Ph.D. from University of Chicago. Author of works on psychology, education and engineering, Dr. Smith is president of Rochester Chapter, National Vocational Guidance Ass'n, and a member of Phi Beta Kappa and of the Society for the Promotion of Engineering Education.**

The idea was not enthusiastically received at the college, where Professor Schneider was then teaching, and it was not until he had moved to the University of Cincinnati that he had the opportunity to put his idea into practice. From a small beginning at Cincinnati in 1906 the popularity of this plan has grown until during the school year 1940-41 sixty-six colleges, technical institutes and junior colleges were offering this type of education.

As may be inferred from the above quotation, the principal function of cooperative work is to provide a series of experiences so that as the student alternates between school and work he will better understand the relationship between theory and practice. The techniques most frequently used to achieve this closer relationship are as follows: (1) By means of sequential, graded job experiences related to the student's major field of study. The work schedule on which tool engineering students at the Rochester Institute of Technology are placed will be described later in this article. (2) From periodic reports obtained from industry concerning student progress on the job. These reports make it possible for the school to become aware of discrepancy between performance in the classroom and on the job. (3) From conferences between the school coordinator and the industrial coordinator. Such conferences provide the opportunity for a discussion of the progress of individual students and the exchange of ideas so that the entire program may

1 Hagberg, Sherman, " 'Engineering,' a Tool Engineering Curriculum," THE TOOL ENGINEER, May, 1945, pgs. 28-32.

2 By cooperative education or cooperative work program is meant that type of curriculum which includes alternation between regularly scheduled instructional periods in school and periods of employment in industry with definite provision for integrating the work experience into the total education of the student.

3 Park, Clyde W., "The Cooperative System of Education," pg. 8, Bulletin 1916, No. 37, Dept. of Interior, Washington, Govt. Printing Office, 1916.

be mutually beneficial. (4) By cooperative work reports obtained from students. It is possible through the assignment of different topics for these reports to assist the student to understand more clearly the function of the department in which he may be working and to provide him with a more comprehensive picture of the organization of the company as a unit.

Although most educators are agreed that work experience is a valuable adjunct to the school program, there are certain advantages and disadvantages of this type of training to both the employers and students which should be mentioned.

Advantages and Disadvantages of Cooperative Work to Employers

An educational institution must depict to employers the advantages of cooperative work, and the following are two of the most important: (1) It provides a continuous source of supervisory and executive personnel. (2) It serves as a testing ground which enables industry to choose those employees of greatest promise. Evidence of the first of these two values is indicated in a survey which the Supervisor of the Electrical Department of the Rochester Institute of Technology made of men who had graduated from his department from 1925 to 1939. Of the 337 graduates accepted as trainees by cooperating companies, 44.8 per cent were still with the same firms in January, 1940, and 19.6 per cent had shifted to some other cooperating company. A type of education which provides trained personnel to industries and reduces the employee turnover to figures as low as indicated is looked on with interest and satisfaction by industrial leaders of the community.

The second advantage of cooperative work to employers is that it serves as a testing ground for both the employer and the employee. Early in the course, some cooperative students discover that the field which they have chosen does not appeal to them or does not hold the attraction which it did before going to work. The advantage of this is indicated by the director of training of a large corporation which employs students from Alabama Polytechnic Institute, Georgia School of Technology and the University of Tennessee. He said:

"The cooperative education plan provides industry with an effective method of employee training through which high type employees may be located, trained and matured on the job without the necessity of conducting an unduly expensive plan of finding, selecting and training employees. Vocational adjustment takes place throughout the course and thereby lessens 'turnover' of employees and consequently saves money for industry."[4]

[4] A. S. Hotchkiss, "Our Purposes and Aims in the Employment of Cooperative Students." *Journal of Engineering Education*, XXIX (January, 1939), pg. 418.

There are certain disadvantages of this type of training, the most important of which are: (1) the cost of the training; (2) the lack of continuity of work, due to students' alternating; and, (3) the possible resentment of foreman and other workers against cooperative students.

It is true that the initial cost of employing a cooperative student is high in proportion to the work done. It costs as much to interview him, give him a physical examination, place his name on the necessary records, and teach him the duties he is to perform as it would for a full-time worker. Although the initial cost is relatively high, this would not appear to be a serious objection, if the cost is distributed over the total length of employment of the student.

The contention that the periodic alternation of two men on one job causes a lack of continuity, which interferes with normal production, has in a large measure been lessened by the longer work blocks which most colleges and universities now employ, namely, ten to thirteen weeks.

The third objection that foremen and other workers might resent the cooperative students is apparently not serious for during the school year 1940-41 there were 325 firms employing Cincinnati students and 112 firms employing Rochester students. Several other colleges and universities were also cooperating with more than 100 individual employers.

Although there is no evidence that the foremen have ever been enthusiastic over training two men to do the work which might be done by one full-time employee, neither is there any considerable evidence which indicates that foremen or other employees resent cooperative students.

Advantages and Disadvantages of Cooperative Work to Students

There are numerous advantages and some disadvantages of cooperative education to students. Because of lack of space, these can only be mentioned and no attempt will be made to prove or disprove them. Some of the most important advantages of cooperative work are: (1) It enables students to visualize the relationship between theory and practice much more readily than graduates of full-time courses. (2) It provides a financial return to the student while he is in school. (3) It provides an understanding of the discipline required in industry and enhances ability to get along with fellow workers. (4) It tends to increase interest in, and motivation for, school work. (5) It assists in understanding the problems of both labor and management. (6) It leads to permanent employment after graduation.

The disadvantages sometimes noted by students are: (1) The length of the student's course is increased, as it takes longer to complete the same amount of work on a cooperative schedule than it does on a full-time schedule. (2) There is some confusion and lost motion occasioned by shifting from school and back again. (3) It is impossible for students to participate in extra-curricular activities to the same extent

Rochester Institute of Technology students making tensile tests.

Machine Division, tool room, Gleason Works.

as full-time students. (4) The students forget a considerable amount of the academic work while on the job.

In summarizing the advantages and disadvantages of cooperative education, it appears that this plan has considerable merit. Evidence that it has been mutually profitable to students, institutions and employers, is indicated by the fact that seventeen programs have been in continuous operation for twenty years or more. In order to demonstrate the manner in which a program actually operates it is believed that a brief description of the cooperative jobs to be held by students while on the work block will be of interest.

The Rochester Institute of Technology Cooperative Tool Engineering Program

After considerable preliminary work on the part of the local chapter of the A.S.T.E. and the Institute faculty, the tool engineering program at the Rochester Institute of Technology was initiated in September, 1945. It is, of course, too early to measure the effectiveness of this program, but inasmuch as the Institute has had other cooperative programs in operation continuously since 1912, the venture into this type of education is not new to the faculty or the industries of this area.

Under the present plan, students alternate between ten-week periods of classes and ten weeks on the job during the school year. This plan serves to provide two students for each job, one of whom will be working while the other is in school. The administration of this program is under the direction of Mr. Herman Martin, Supervisor of the Mechanical Department. Mr. Martin has had 29 years experience with cooperative education and is well aware of all the problems encountered in administering a program of this kind. Of even greater importance, however, is his intimate knowledge of the needs of the various cooperating industries. As department head, he is also responsible for counseling students and has at his command each student's high school record, results of interviews and classification examinations, and incidents of student behavior noted by faculty members.

On the basis of the needs of the various companies, students are sent out for interviews. Although the actual hiring is done by personnel men in industry, considerable weight is usually given to the department head's recommendations. Since the Institute can best serve its purpose by meeting the needs of both, employer and student, care is taken that the student sent for an interview is of the type best suited to work in a particular organization, and, on the other hand, that the job will be most beneficial in the student's total educational program.

The companies employing Institute students are all located in Western New York. These organizations view students as supervisory material in training and normally arrange a sequence of jobs so that a student has the opportunity to obtain an overall picture of the processes in a plant. In fact, in the organization of the tool engineering curriculum a committee of the local chapter of the A.S.T.E.[5] formulated a proposed work schedule for the entire three-year program which is illustrated in Table I below. There are several features about Table I which should be noted: (1) The program is divided into years and subdivided into two ten-week work blocks and the ten-week summer work period. (2) The purpose of each work block is stated. (3) The actual jobs and approximate length of time to be spent on each job is indicated.

TABLE I
PROPOSED WORK SCHEDULE FOR COOPERATIVE TOOL ENGINEERING STUDENTS

[5] The authors wish to acknowledge the valuable help which these men have given: William Gordon, Byron Hill, Emmet Moore, Milton Roessell.

First Year

First Work Block (10 Weeks)

Purpose: To acquaint the student with the manner in which the work originates.

1. Errand or Acquaintance Service—4 weeks
2. Clerical Work in Tool Engineering Department—6 weeks

a. Checking Tool Orders b. Checking Factory Orders

Second Work Block (10 weeks)

Purpose: To familiarize the student with shop tools.

1. Tool Crib
   a. Tool Sharpening—Drills, Taps and Single Point Tools—4 weeks

Purpose: To provide actual experience on Engine Lathes.

1. Lathe work in the tool room—6 weeks

Summer Work Period (10 weeks)

Purpose: To provide experience on various types of machines in the tool room.

1. Work on Milling Machines and Shapers—5 weeks
2. Work on Drill Presses and Grinders—5 weeks

Second Year

First Work Block (10 weeks)

Purpose: To provide experience on the various grinders used in the tool room.

1. Work on Cutter, Surface, Cylindrical and Internal Grinders—10 weeks

Second Work Block (10 weeks)

Purpose: To provide experience in Tool Repair.

1. Work on Jigs, Fixtures, Cutters, Dies and Moulds—10 weeks

Summer Work Period (10 weeks)

Purpose: To provide acquaintanceship with work of Tool and Die Makers.

1. Work on Dies, Jigs and Fixtures

Third Year

First Work Block (10 weeks)

Purpose: To provide experience on production machines used in the General Machine Shop of the Production Department.

1. Hand Screw Machines—2 weeks
2. Automatic Screw Machines—2 weeks
3. Production Milling and Grinding—2 weeks
4. Product Assembly—2 weeks
5. Inspection—2 weeks

Second Work Block (10 weeks)

Purpose: To provide an understanding of the methods of costs and controls and an understanding of the work of the Tool Design Department.

1. Work on Costs and Control in the Time Study Department—4 weeks
2. Work in the Tool Design Department—6 weeks

A study of the jobs on which students are placed reveals that there is a broad relationship between these and the courses studied in school. This makes it possible for the student to visualize practical application of some of the theories he has studied, hence provides him with a keener understanding of these theories and principles. During the time that the student is on each work block he will receive the regular starting wage for the job he is doing. As a worker, he will face the same problems of adjustment to the foremen and fellow workers which are faced by other beginning workers.

The tool engineering course is just getting under way, and it is possible that the work schedule outlined above will have to be modified in the light of experience. It is believed, however, that the provision of these job experiences will afford each student the opportunity of understanding some of the problems of labor and management and will make more real the principles studied in textbooks.

A.S.T.E. NEWS

NEWS OF INTEREST AND ABOUT MEMBERS

Cleveland To Welcome ASTE Exposition With Sesquicentennial

IN 1796 WHEN MOSES CLEAVELAND laid out the Public Square, Cleveland was an isolated trading post on the Western Reserve frontier. This year, when it celebrates the 150th anniversary of its founding, it is the nation's sixth city—a great metropolis of more than a million people.

Cleveland's sesquicentennial, to be observed with a year-long program of events marking the city's rise as an important industrial center, provides an appropriate setting for the ASTE New Era Exposition. Largest exhibition of its kind ever sponsored by the Society, the show will cover the entire five and three-fourths acres of Cleveland's huge Public Auditorium, from April 8-12. Many of the Ohio city's manufacturers of fixtures, gages, small tools, and related products will be represented as exhibitors.

Plants engaged in these and other ramifications of Cleveland's industry will hold open house to members of the Society who will thus have an opportunity to see the actual construction of equipment used in their daily work, as well as new and hitherto secret processes developed during the war.

The vast marine traffic of the inland seas, in combination with the coal and limestone fields of Ohio and Pennsylvania, has made Moses Cleaveland's settlement on the south shore of Lake Erie a natural site for smelting and processing the cargoes of iron ore brought down from Duluth; for shipping the finished merchandise to eastern lake ports and through the St. Lawrence to Europe.

Next spring, lake carriers may help bring industrial travelers to Cleveland to view the big ASTE show.

Many others will come via the excellent air, rail and motor transportation serving this centrally-located city which is only an overnight trip for half the population of the U. S. and Canada.

Requests for hotel accommodations already received indicate a record attendance for the combined Annual Meeting and Exposition. On February 1 these applications for reservations will be turned over to the Cleveland Housing Bureau who will make assignments on an equitable basis, utilizing to the best advantage Cleveland's modern hotel facilities.

Hotel Statler will be the Society's official headquarters, but other leading hostelries have made large blocks of rooms available to ASTE. Visitors are urged to engage accommodations for the minimum of time essential to the completion of their business, stating time of arrival and departure as accurately as possible.

Cleveland Public Auditorium is within walking distance of the downtown hotel district. Its various exhibit halls permit spacious displays and uncrowded passage.

On December 15 National Program Chairman H. D. Hall and his committee gathered at Cleveland for a two-day session to formulate tentative plans for technical sessions, plant tours, motion picture programs, and educational features for engineering students. The February TOOL ENGINEER will carry complete information concerning all convention details, as announced by Mr. Hall.

Important in the progress of the big ASTE industrial get-together is the efficient service rendered by Cleveland Chapter Chairman Joseph I. Karash and his committee in making local arrangements. This group has worked diligently ever since the announcement of the show, originally scheduled for last March.

From the cooperation being received on every hand, it is apparent that Cleveland's welcome mat will be out for ASTE visitors during its 150th birthday party.

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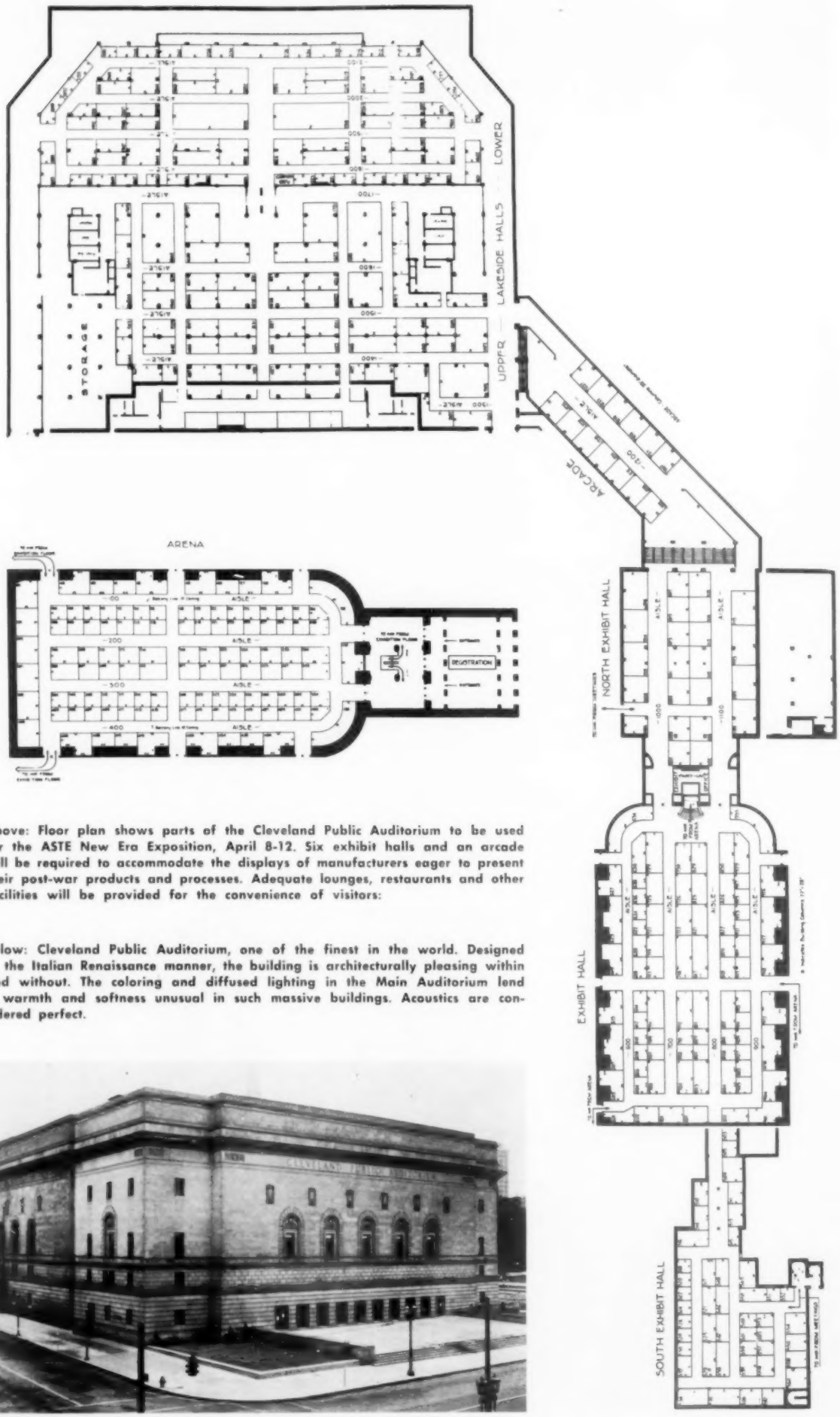
Cleveland—the nation's sixth city—as seen from the air, looking east. At upper left is Lake Erie and part of the city's 14 miles of lake front. Round structure on the waterfront is the stadium. Tall building (upper center) is Terminal Tower. Midway between these points is the Public Auditorium (long, low building) where the Society's New Era Exposition will be held April 8-12.



Above: Floor plan shows parts of the Cleveland Public Auditorium to be used for the ASTE New Era Exposition, April 8-12. Six exhibit halls and an arcade will be required to accommodate the displays of manufacturers eager to present their post-war products and processes. Adequate lounges, restaurants and other facilities will be provided for the convenience of visitors.

Below: Cleveland Public Auditorium, one of the finest in the world. Designed in the Italian Renaissance manner, the building is architecturally pleasing within and without. The coloring and diffused lighting in the Main Auditorium lend a warmth and softness unusual in such massive buildings. Acoustics are considered perfect.

Here Is Cleveland—Setting For ASTE New Era Exposition

Show and Convention To Run Concurrently, April 8-12

Above, left: Hotel Statler, official Society convention headquarters. Here the House of Delegates, Board of Directors and various committees will assemble for their respective meetings.

Upper right (top): A section of the Main Exhibition Hall in Cleveland Public Auditorium, looking toward the stairway leading to the Arena. These, with the North, South, and Lakeside Halls, will house the Exposition exhibits.

Upper right (bottom): Famous Euclid Avenue, Cleveland's main thoroughfare. Photo shows East 8th Street intersection in the busy downtown shopping district.

Lower right: Silhouetted against the evening sky is part of the extensive manufacturing facilities which have made Cleveland the nation's sixth city. Visits to some of these plants will be included in the convention program.

A BATTLE STAR FOR THE TOOL ENGINEER

Reprinted from MODERN MACHINE SHOP

THE WAR IS ENDED — won by American soldiers and sailors and airmen who met the enemy and whipped him on the seas, in the air and on the land. To these boys America owes a debt that can never be paid.

America pays tribute to its fighters, but at the same time derives a certain amount of satisfaction from the fact that it gave its fighters the best in fighting equipment and in quantities sufficient to overwhelm the enemy.

This war has been a war of production—a war the outcome of which depended upon the ability of one nation to overcome the other by the power and quantity of its arms. The nation that could not meet the production challenge faced defeat. And America won—won because it had behind its production front a corps of highly-trained specialists who are unequalled in their skills in any country in the world. These are the Tool Engineers. American Tool Engineers won the Battle of Production, without which all of the other battles would have been lost.

The best of factories can be built; the best of equipment can be installed; the best in materials can be procured—but the successful coordination of these factors for the maximum possible production depends, in the last analysis, upon the peculiar abilities of the Tool Engineer—abilities in which the imagination of the inventor is combined with the techniques of the skilled artisan and the training of the mechanical engineer.

* * *

It is the Tool Engineer who decides upon the manufacturing process that will produce a completed piece in the shortest possible time; it is the Tool Engineer who decides upon the type of machine that will make it possible to achieve this objective; it is the Tool Engineer who plans the tools that are to be used on the machine in which the piece is to be machined; it is the Tool Engineer who plans the means by which the parts in process will be moved from one operation to another so that a minimum of time will be lost between production operations. During the past four years the Tool Engineer's burden has been heavy indeed, but he has carried it creditably.

The science of "tool engineering" is largely a development of the American automobile industry. It is true that some fine tooling has been done in the manufacture of telephones at the Western Electric Plant in Chicago, and in some of the sewing machine factories, but the unparalleled development of the automobile industry offered a new and great opportunity for the ingenuity and inventiveness which have been peculiarly characteristic of the American people.

From the designing of the simple jigs and fixtures with which the automobile industry started out, tool designing gradually developed into a highly-specialized branch of engineering in which the traditional ideas of tool cost limitations and manufacturing methods were scrapped to meet the ever-increasing demand for higher production and lower unit costs.

* * *

As pressure for production increased, the demands upon the Tool Engineer increased and his abilities were necessarily widened to include a knowledge of machine design, toolmaking, heat treating, materials, and cost accounting, and through these abilities he became the originator of machines and tools that are the marvel of the manufacturing world.

Today all of America's greatest industries have their Tool Engineers, upon whom they depend for maximum production and minimum costs. In the recent conflict American Tool Engineers won the Battle of Production, and we here and now nominate them for a Battle Star or its equivalent.

Howard Campbell,
Editor, MODERN MACHINE SHOP

Explains Mold Making For Rubber Goods

Cincinnati, Ohio — ASTE'er Herman O. Poock, Master Mechanic, Inland Manufacturing Div., G.M.C., Dayton, explained "Molds as Applied to Rubber Products," to Cincinnati Chapter when its members met November 13 at the Engineering Society Headquarters.

H. O. Poock

Mr. Poock introduced his subject with a film, "Isle of Yesterday," showing the development of a Sumatra rubber plantation from the planting of hevea trees to the shipping of crude rubber. With slides he illustrated his description of mold designing and the types of steam-heated presses used. He also discussed mold building, cavity hobbing, and rubber properties.

Mr. Poock's staff, Guy Jones, Technical Superintendent; Ray Vogel, Tool Room Supervisor; James Hutchinson, Mold Foreman; and James Bashor, Tool and Die Foreman, assisted the speaker in answering the technical questions asked at the conclusion of his lecture.

Nearly 80 members of the Chapter had the pleasure of hearing Mr. Poock. A buffet dinner preceded the meeting.

Sheldon Wins Promotion At Gilbert & Barker

Springfield, Mass.—Edward C. Sheldon, formerly Assistant Manufacturing Superintendent, Gilbert & Barker Manufacturing Company, West Springfield, has been promoted to Manufacturing Superintendent.

E. C. Sheldon

In his new capacity, Mr. Sheldon has charge of all production departments of the company. Established in 1865, Gilbert & Barker is one of the leading manufacturers of gasoline pumps and other service station equipment, as well as oil burners and warm air heating equipment.

Mr. Sheldon came to Gilbert & Barker in 1923 as Assistant General Foreman of the Machine Shop. Two years later he became General Foreman, and in 1944, he was made Assistant Manufacturing Superintendent.

Earlier he was associated for 14 years with J. Stevens Arms Company, Chicopee Falls, as Foreman and Chief Inspector. At Westinghouse Electric & Mfg. Company, East Springfield, he was employed for a year as Assistant Foreman.

In Springfield Chapter, ASTE, Mr. Sheldon has held office as Treasurer and Chairman. A past President of the Springfield Industrial Association, he has been prominently identified with service organizations in this area.

Coming Meetings

ALL CHAPTERS—February. Election of Chapter Officers and representatives to the House of Delegates.

CINCINNATI — Annual Dinner Dance, January 19, at Hotel Alms.

DAYTON—February 11 at the Engineers Club. Speaker: R. N. McGee, Jones & Laughlin Steel Corp., Pittsburgh, Pa. Film on the making of wire and wire rope, followed by open discussion.

MILWAUKEE — Dinner Dance, January 26, at Elks Club.

NEW HAVEN—February 14, Chi Psi House. Dinner, 6:30 P.M. Speaker: W. C. Whittum, Production Engineer, Farrel-Birmingham Company, Ansonia, Conn. Subject: "Production Engineering for Heavy Machinery."

NEW ORLEANS—February 12. Film on "Milling," sponsored by Cincinnati Milling Machine Company.

NEW YORK, GREATER—Annual Dinner Dance, January 26, Grand Ballroom, Hotel New Yorker. Splendid program being planned under direction of Entertainment Chairman Julius Schoen.

SYRACUSE—February 12, 8:00 P.M., Hiawatha Room, Onondaga Hotel. Speaker: Arthur A. Schwartz, Chief Tool Engineer, Bell Aircraft, Buffalo, N. Y. Subject: "New Production Horizons." February 16, Annual Dinner Dance, Onondaga Hotel.

TORONTO—February 11, 6:30 P.M., Malloney's Art Gallery. Speaker: Werner Senger, Gisholt Machine Company, Madison, Wis. Subject: "Balancing Machines." Film: "Set-Up and Tooling Turret Lathes."

Potter New England Head Of Patent Council

Gary, Ind.—Adrian L. Potter, formerly Executive Secretary of the American Society of Tool Engineers, has been appointed staff head of the New England division of the National Patent Council, John W. Anderson, President, has announced. The Council, a new organization of smaller manufacturers, has been set up to defend the Patent System and to develop a better understanding and appreciation of patents, invention and research.

A. L. Potter

A grass-roots program on behalf of the Patent System, emanating from local manufacturers, inventors and research men throughout New England, will be directed by Mr. Potter, according to Mr. Anderson.

Mr. Potter, a member of Detroit Chapter, ASTE, recently resigned his post of Executive Secretary for the Society after three and a half years of service in this capacity. For 16 years prior to April of 1942, he was manager of the Convention Bureau at Springfield, Massachusetts, his native city. Earlier, he spent several years as a Tool Designer for various New England plants. In his new position, Mr. Potter will make his headquarters at Boston.

"The great number of smaller manufacturers and patent lawyers from New England who have already become affiliated with the Council demonstrates that area's recognition of the responsibility for developing a better understanding and appreciation of the Patent System," Mr. Anderson pointed out.

"Mr. Potter knows New England and he has an ideal background for the important duties he is undertaking for the National Patent Council in New England, birthplace of the American inventive ingenuity which has made this country the world's greatest industrial nation," said Mr. Anderson.

5-Point Program for IRC

Detroit, Mich.—Members of the Independent Research Committee on Cutting Fluids recently held their annual meeting in Detroit, according to Joseph Geschelin, Chairman. Organized about eight years ago for the purpose of studying the utilization of cutting fluids, improving commercial practice, and the preparation of recommendations for metal cutting establishments, the IRC has presented papers on these subjects before the principal engineering societies. Its manual on cutting fluid recommendations and machinability tables for the commonly-used engineering materials has been widely used and incorporated in handbooks and bulletins.

Five major projects of interest to the metal working industry have been initiated by the IRC. These are as follows: 1.—definitions and nomenclature; 2.—refrigeration of cutting fluids; 3.—study of industrial dermatitis; 4.—survey of machining practice in the aircraft industry; and 5.—revision of the machinability tables.

The IRC studies special problems of metal cutting plants upon request.

Naval Ordnance To Create New Engineering Rating

Washington, D. C.—Realization that the so-called Professional or Ordnance Engineer is not familiar enough with tooling and production to design new ordnance with an eye to manufacturing has resulted in Naval Board acceptance of plans to establish two grades of engineers, Rear Admiral W. A. Kitts III, Assistant Chief, Bureau of Ordnance, Navy Department, indicated to Potomac Chapter when he was guest speaker at the Third Annual Executives Night held November 1 in Hotel 2400.

In the new setup, the engineers who will design ordnance strictly from a performance standpoint will continue to be rated as Ordnance Engineers, Admiral Kitts explained. Plans include an additional grade of Product Engineer—personnel expected to be recruited from organizations such as ASTE. These men will convert engineering drawings into practical working drawings for tooling and production purposes, and serve as liaison between Naval Ordnance and manufacturers who will be given pilot orders from time to time. In the event of an emergency, these engineers can be assigned to various plants to expedite manufacture for the Navy.

This engineering section would coordinate with Ordnance design in material processing, setting up of cost controls, performance standards, job operation analysis, and other means of determining methods and gaging standards for operational performance.

Thomas P. Orchard, Third Vice-President of ASTE, representing the National Officers, was asked to comment on this arrangement. Mr. Orchard commended this forward-thinking action by the Navy, and also mentioned the need for a Civil Service rating with remuneration adequate to permit qualified engineers to enter such service.

Admiral Kitts concurred in this, but pointed out that an engineering degree would be required for a Civil Service rating on a professional basis, carrying an adequate salary. He stated, however, that he would recommend that the rating contain a clause specifying eight years of practical experience as an alternative qualification. Suggestions from the Society for working out this new development would be welcomed by his department, Admiral Kitts said in thanking Mr. Orchard for his contribution to the discussion.

Serving in both World Wars, Admiral Kitts has had a colorful naval career since his graduation from Annapolis in 1916. He holds many medals and awards for distinguished service in the Navy, and a degree of Master of Science granted by Massachusetts Institute of Technology.

Distinguished guests among the 200 who heard Admiral Kitts included Capt. J. M. Taylor and Lt. Comdr. W. Winkel, Naval Gun Factory; Capt. W. B. Schindler, Naval Ordnance Laboratory; Comdrs. R. J. Woodaman, I. W. Ulrey, and W. L. Tann, Navy Dept.; Capt. W. C. Vose and Comdr. C. O. Glisson, Naval Torpedo Station; Comdr. W. W. Timmis, U.S.N.R., who served as coffee speaker; and L. C. Steward, National President, National Federation of Federal Employees.

ASM And ASTE Groups Meet Jointly

Portland, Ore.—The local chapters of ASM and ASTE conducted a joint meeting at the Congress Hotel recently.

Carl Strout, Pacific Coast Manager of the File and Hacksaw Division, Simonds Saw and Steel Company, Fitchburg, Massachusetts, was the technical speaker. His subject, "The Manufacture, Use and Misuse of Hacksaws," was illustrated with a Kodachrome sound film of the same title. Mr. Strout described in an interesting manner the new Simonds factory and manufacturing methods.

A half-hour question and answer period followed his discussion.

Coffee speaker of the evening was Ben H. Hazen, President of Benjamin Franklin Savings and Loan Association of this city. In his talk on "Public Relations in 1946," he analyzed the salient points essential to better public relations.

ASTE was represented at the meeting by an attendance of approximately 50.

Distinguished guests at Potomac Chapter's Third Annual Executives Night, held November 1 in Hotel 2400, included many naval officers. Principal speaker was Rear Admiral W. A. Kitts, III. Seated at speakers' table, left to right, are: Lt. Comdr. W. Winkel, U.S.N.R.; Comdr. W. L. Tann, U.S.N.; L. C. Steward, National President of National Federation of Federal Employees; Comdr. C. O. Glisson and Capt. W. G. Schindler, U.S.N.; D. T. Hilleary, Chapter Secretary; Capt. W. C. Vose and Rear Admiral W. A. Kitts, U.S.N.; Lawrence Didszoneit, Chapter Chairman; Comdr. W. W. Timmis, U.S.N.R.; Capt. J. M. Taylor, U.S.N.; T. P. Orchard, Third Vice-President, ASTE; Comdr. R. J. Woodaman, U.S.N.; Lt. Comdr. I. W. Ulrey, U.S.N.R.; and R. P. Thayer, Chapter First Vice-Chairman.

Chapters Consider Nominees for '46-'47 Directors

A SLATE OF 21 NOMINEES for election to the 1946-47 ASTE Board of Directors has been submitted to the Chapters for consideration at their January meetings, by the Annual Nominating Committee, as prescribed in the recently-adopted Constitution.

The Committee, composed of Ray H. Morris, Chairman; K. C. Jasper, G. J. Hawkey, F. W. Eaton and L. G. Singer, feels "after careful study of the records and facts at hand" that "most of these candidates have outstanding qualifications and that their record of team-work would indicate assured success to American Society of Tool Engineers' plans and objectives."

B. C. Brosheer

W. A. Dawson

A. J. Denis

W. J. Frederick

H. E. Goodfellow

C. A. Holmer

K. L. Bues

A. F. Denham

R. B. Douglas

W. J. Gamble

I. F. Holland

K. C. Jasper

A supply of brochures, containing biographical data and photographs of the candidates, as well as an outline of the new procedure for election, has been mailed to each Chapter. At the January business meetings, all local ASTE groups will indicate their choice of these nominees, to guide their representatives to the House of Delegates meeting in April.

The Delegates, following instructions from their respective Chapters, will cast ballots for the ten Directors who, with the retiring President, will constitute the new streamlined Board.

Other business to be transacted in January Chapter meetings includes the election of Chapter Nominating Committees to present candidates for Delegates and Alternates to the House of Delegates, and nominees for Chapter officers. In February, members will ballot to elect the Delegates and Alternates, and officers to direct their Chapters for the '46-'47 season.

The 21 nominees for Directors, who "by their past record, indicate their scope of administrative experience, business ability, and applied effort in Society affairs," are:

BEN C. BROSHEER—Associate Editor, *American Machinist*, McGraw-Hill Publishing Co., Chicago, Ill. Senior member since 1937; Charter Member, Sec'y and 1st Vice Chmn., Northern New Jersey Chapter; Chmn., Public Relations and Industrial Relations Com.'s, Chicago Chapter; Chmn. Nat'l Industrial Relations Com.; Incumbent Member, Nat'l Public Relations Com. Varied industrial experience since 1923.

KARL L. BUES—Consulting Mfg. Eng., San Francisco, Calif. Senior Member since 1939. Charter Member, Sec'y (two terms), Vice-Chmn.; Chmn.; Chmn., Publicity, Editorial, Standards, Education and Program Com.'s, Golden Gate Chapter. Western Area Vice-Chmn., Nat'l Industrial Relations Com. Industrial Executive and Tool Engineer since 1923. Member, California State Board of Education Apprentice Training Com.; Instructor in Tool Eng'g and Production Eng'g, University of California. A regular contributor to technical publications.

WILLIAM A. DAWSON—Executive, F. F. Barber Mchry. Co., Toronto, Ont. Senior Member since 1941. Charter Member and first Chmn., Hamilton Chapter. Member, Nat'l Editorial Com.; Incumbent Director and Nat'l Asst. Sec'y-Treas.; Has held responsible industrial executive positions in Plant Management and Tool Engineering since 1930. Active in numerous professional, technical and civic associations and societies. Holds B. S. Degree in Mechanical Eng'g.

ATHEL F. DENHAM—President, Denham & Co., Detroit, Mich. Senior Member since 1937. Incumbent Chmn., Nat'l Public Relations Com. (two terms); Engineer, Editor, and Executive since 1923. Specializes in Publicity and Public Relations work.

ARTHUR J. DENIS—Pres., Murphy-Denis Corp., Los Angeles, Calif. Senior Member since 1934. Chapter activities: Publicity, Public Relations, Editorial, and Education Com.'s, and Chmn., Los Angeles Chapter. Incumbent Director. Industrial Executive and Tool Engineer since 1930. Holds B. S. Degree in Mechanical Eng'g.

ROBERT B. DOUGLAS—Works Mgr., Propeller Div., Canadian Car & Fdry. Co., Ltd., Montreal, Que. Senior Member since 1941. Charter Member, 2nd and 1st Vice-Chmn., and Chmn., Montreal Chapter. Canadian Area Vice-Chmn., Nat'l Standards Com., Member, Publications Com., and various special committees. Incumbent Member, Handbook Com., and Director. Industrial Administrative Executive and Engineer since 1938. Active in technical and professional associations. Holder of M. S. Degree.

WILLIAM C. FIELDS—Chief Tool Research Eng., Boeing Aircraft Co., Seattle, Wash. Senior Member since 1942. Chapter Chmn.; Chmn., Membership and Public Relations Com.'s, Seattle Chapter. Incumbent Director. Active in various community club groups.

W. J. FREDERICK—Pres., Frederick Steel Co., Cincinnati, Ohio. Senior Member since 1939. Treas. and Chmn., Cincinnati Chapter. Member, Organization Progress Com. Incumbent Nat'l Treas., and Director (second term).

WILLIAM J. GAMBLE—Mfr.'s Rep., Buffalo, N. Y. Senior Member since 1938. Chmn., Resolutions Com., Membership Com., and Chapter Chmn., Buffalo-Niagara Frontier Chapter. Incumbent Director. Industrial and Production Executive since 1911. Has served actively in executive positions in nationally-known technical and civic organizations.

HARRY E. GOODFELLOW—Chief Products Eng., Winters & Crampton, Grandville, Mich. Senior Member since 1940. Treas., 1st Vice-Chmn., and Chmn., Western Michigan Chapter. Incumbent Director. Industrial executive and engineer since 1936.

IRWIN F. HOLLAND—Gen. Supt., Small Tool & Gage Dept., Pratt & Whitney, Div., Niles-Bement-Pond Co., W. Hartford, Conn. Senior Member since 1936. Chmn., Program, Constitution and By-Laws Com.'s, and Chapter Chmn., Hartford Chapter. Chmn., Nat'l Editorial, Nat'l Nominating, and Nat'l Resolutions Com.'s. Director (two terms); Member, Organization Progress Com. Incumbent Chmn., Natl Constitution and By-Laws Com. (third term). Industrial Production Executive since 1915. Active in various technical and professional societies.

CARL A. HOLMER—Supt., Tool Room, Caterpillar Tractor Co., Peoria, Ill. Senior Member since 1940. Vice-Chmn.,

and Chmn., Peoria Chapter. Incumbent Member, Nat'l Finance Com., and Director. Has given valuable assistance to the Nat'l Education Com. in their apprentice training program. Industrial Executive and Tool Engineer since 1931.

KENNETH C. JASPER—Methods Eng.—Westinghouse Elec. Corp., Louisville, Ky. Senior Member since 1937. Active in organization of and Charter Member, Sec'y., and Treas., Tri-Cities Chapter. Also active in formation of Louisville Chapter—Charter Member and Chmn. Incumbent Director. Industrial Executive, specializing in Methods and Tool Engineering, since 1929. Active participation and executive positions in various technical, professional and civic organizations.

Frank Martindell

W. B. Peirce

A. M. Sargent

H. F. Volz

T. P. Orchard

L. J. Radermacher

A. M. Schmit

G. S. Wilcox, Jr.

FRANK MARTINDELL—Product Development Eng., Illinois Watch Case Co., Elgin, Ill. Senior Member since 1941. Vice-Chmn., and Chmn., Chicago Chapter. Member, Nat'l Education Com. Incumbent Member, Handbook Com.; and Director. Industrial Executive and Engineer since 1926. Graduate Mechanical Engineer.

THOMAS P. ORCHARD—Partner and Gen. Mgr., American Tool Eng'g Co., New York City. Senior Member since 1938. Charter Member and Chmn., Entertainment Com., Northern New Jersey Chapter. Charter Member, Vice-Chmn., and Chmn., Greater New York Chapter. Incumbent 3rd Vice-Pres., and Director. Industrial Executive, Tool Engineer; and Supervisor, Student Training, since 1914.

W. B. PEIRCE—Vice-Pres., Research and Development, Flannery Bolt Co., Bridgeville, Pa. Senior Member since 1938. Vice-Chmn., and Chmn., Pittsburgh Chapter. Chmn., Nat'l Membership Com. (two terms); Member, Organization Progress Com., 3rd Vice-Pres. Incumbent 2nd Vice-Pres., and Director (third term). Industrial Executive holding top administrative positions since 1907. Director of various manufacturing plants. Active Executive in technical, professional and civic organizations.

LAWRENCE J. RADERMACHER—Pres., and Gen. Mgr., Stokerunit Corp., Milwaukee, Wis. Senior Member since 1936. Charter Member, Chmn., Program Com.; and Vice-Chmn., Milwaukee Chapter. Chmn., Nat'l Time and Place, Credentials, Nominating, and Program Com.'s, and ASTE Machine Tool Progress Exhibition 1943. Incumbent Director. Executive Engineer since 1921.

ALBERT M. SARGENT—Chmn. of Board, Pres., and Gen. Mgr., Pioneer Eng'g & Mfg. Co.; Pioneer Pump & Mfg. Co.; and Pioneer Industries, Detroit, Mich. One of founders of ASTE and Senior Member since 1932. Service on Nat'l Constitution and By-Laws, Nat'l Standards, Nat'l Editorial, and Organization Progress Com.'s. Nat'l Sec'y (five terms), 2nd Vice-Pres., Incumbent Director (eighth term), and 1st Vice-Pres. Industrial Administrative Executive in Tool Engineering since 1916. Consulting Production and Industrial Engineer. Actively participates in technical, professional, civic and industrial organizations.

A. M. SCHMIT—Owner and Gen. Mgr., A. M. Schmit Co., Toledo, Ohio. Senior Member since 1937. Member, Toledo Chapter. Incumbent Director and Nat'l Sec'y. Industrial Executive, specializing in Inspection and Production Control, since 1916.

HOWARD F. VOLZ—Sales Rep., C. H. Gosiger Mchry. Co., Dayton, Ohio. Senior Member since 1938. Sec'y, Cincinnati Chapter; 2nd Vice-Chmn., 1st Vice-Chmn., and Chmn., Columbus Chapter. Incumbent Director. Sales Engineer, Tool Engineer and Production Executive since 1919.

GRANT S. WILCOX, JR.—Asst. Master Mechanic, Plymouth Div., Chrysler Corp. Senior Member since 1937. Chmn., Editorial Com.; Vice-Chmn. and Chmn., Detroit Chapter. Incumbent Chmn., Sub-Committee, Nat'l Standards Com. An active contributor to the Organization Progress Com. Industrial Executive in Tool Engineering since 1939. Active Executive in technical and professional organizations. Holder of B.S. Degree in Mechanical Engineering, and author of articles on aviation.

In addition to the business and Society experience listed by the Nominating Committee, many of these candidates hold important offices in civic, professional, and business organizations.

New Society Data Sheets For "The Tool Engineer"

National Standards Chairman W. H. Smila has appointed Carl J. Oxford, Chief Engineer, National Twist Drill & Tool Company, Rochester, Michigan, chairman of a sub-committee to re-edit, in ASTE data sheet form, engineering information as the beginning of a series to be included in THE TOOL ENGINEER. This monthly reference material will be conveniently indexed for filing.

C. J. Oxford

Work on an adequate index to the Society's Data Sheets is progressing under the direction of Grant S. Wilcox, Jr., Chairman of the Data Sheet Sub-Committee. His committee expects to have the completed index ready for distribution early in the year.

A contract and rate schedule governing the ASTE Data Sheet Distribution Service has been approved by the National Standards Committee, Chairman Smila reports. Copies, and instructions for preparing data sheets, will soon be in the hands of Chapter Chairmen and Standards Chairmen. This information will enable local ASTE Standards Committees to assist manufacturers interested in distributing engineering data to the Society's membership.

W.E.S. Welcomes A.S.T.E. As Affiliate Member

Worcester, Mass.—A joint meeting of Worcester Chapter, A.S.T.E., and the Worcester Engineering Society was held at Putnam and Thurston's on November 6, with an excellent attendance. At this time the A.S.T.E. group received an official welcome as an affiliate member from Stanley N. McCaslin, President of the Worcester Engineering Society.

C. A. Sundstrom

W. S. Larson

Mr. McCaslin, chairman of the meeting, introduced W. S. Larson, Development Engineer and C. A. Sundstrom, Tool Engineer, of the General Electric plant in Pittsfield. Using a very interesting display of plastic products and a film depicting some of the future uses of these materials, Mr. Larson discussed designing for plastics.

Following Mr. Larson's address, Mr. Sundstrom described some of the problems involved in mold tooling.

National Director William W. Young of Boston spoke briefly of the coming tool show and other items of national interest.

The local A.S.T.E. Chapter is one of the seven engineering groups comprising the Worcester Engineering Society.

Germans Could Resume Tool Production Now

Springfield, Mass.—Although its industry has been heavily bombed, Germany could begin the manufacture of machine tools and gages almost immediately, according to ASTE Past President A. H. d'Arcambal, Vice-President and Consulting Metallurgist, Pratt & Whitney Division, Niles-Bement-Pond Company, Hartford, Connecticut, who spoke at Springfield Chapter's "Past Presidents Night," held November 12 in the Highland Hotel.

Mr. d'Arcambal, who had just returned from a ten-week government-sponsored technical investigation of German war plants, asserted that every factory he inspected could start production within a month. While the cities themselves were about 75% demolished, most of the war plants were located on the outskirts where devastation was lighter, he pointed out.

Many of the machine tool and gage plants which he saw had the machinery intact, although roofs and walls had been destroyed. Only about eight pieces of machine tools were ruined for every ton of bombs dropped, he observed.

German manufacturers admitted that the failure of transportation and fuel supply brought about defeat. It was apparent that power plants suffered only slightly, as the Germans could always turn on power when asked to demonstrate their machines, Mr. d'Arcambal commented.

Machine tool plants, the speaker said, were well equipped with German-built machines, augmented by some Swiss and Swedish equipment. American-made tools, generally speaking, were superior to the Germans', but much interesting information was gleaned from German manufacturing methods.

Differing from American practice, Mr. d'Arcambal stated, almost all high speed taps were made with full eccentric relief. Shanks of taps over five-sixteenths were welded. This, and the foreshortening of the cutting-length of the tap, was done to conserve steel, in Mr. d'Arcambal's opinion. Carbon steel taps were roll-threaded to .0005" tolerance.

German manufacturers believe that Germany could have discovered the secret of atomic energy, if Hitler had not refused to defer scientists and technical men for military service, Mr. d'Arcambal concluded.

The local Chapter event honored five of the Society's Past Presidents—R. M. Lippard of Worcester, James R. Weaver and Frank W. Curtis of Springfield, Ray H. Morris and Mr. d'Arcambal of Hartford.

Five former Presidents of ASTE were honored by Springfield (Mass.) Chapter, November 12, on the occasion of "Past Presidents Night." The guests of honor, as shown in the upper photo, are (left to right) R. M. Lippard of Worcester, J. R. Weaver of Springfield, A. H. d'Arcambal of Hartford, F. W. Curtis of Springfield, and Ray H. Morris of Hartford.

The gathering was also distinguished by the presence of seven New England Chapter Chairmen. Lower photo, standing: Arthur A. Nichols, Boston; J. F. Sargent, New Haven; F. W. McQueston, Worcester; and George R. Morin, Twin States. Seated: George A. Highberg, Hartford; E. J. Stone, Springfield; and J. F. McGowan, Little Rhody.

Wisconsin Group Guests Of Ampco

Milwaukee, Wis.—Ampco Metal, Inc., was host to Milwaukee Chapter November 8 when the group assembled in the Company's cafeteria for their monthly dinner meeting.

George A. Dreher, Ampco Works Manager, welcomed the party, and Walter Eden of the Ampco organization gave an interesting technical talk on the company's manufacturing processes and the production of the film, "Golden Horizons." This film, showing in technicolor the manufacture and uses of the company's products, was subsequently screened for the enjoyment of the gathering.

Several visitors from other Chapters were present, including National Assistant Secretary-Treasurer W. A. Dawson of Hamilton, George Ray of Windsor, and Charles Plumber of Toronto. The guests from Canada visited a number of Milwaukee plants the following day.

National Director L. J. Radermacher reported on the Semi-Annual Meeting.

Six visiting New England Chapter Chairmen were present. These included Arthur A. Nichols, Boston; George A. Highberg, Hartford; J. F. McGowan, Little Rhody; J. F. Sargent, New Haven; George R. Morin, Twin States; and F. W. McQueston, Worcester.

Several ASTE'ers from Canada visited Milwaukee Chapter, November 8, when the Wisconsin group held their meeting in the Ampco Metal plant. At left, reading from left to right, are National Assistant Secretary-Treasurer W. A. Dawson of Hamilton, George Ray of Windsor, Charles Plumber of Toronto, and Dick Camel of the Milwaukee Chapter Welcoming Committee. At right is a general view of the group at dinner in the Ampco cafeteria.

Detroit representatives of trade publications and newspapers, who attended the Society's recent press conference at the Book-Cadillac Hotel in Detroit, listened intently to President C. V. Briner's talk concerning ASTE's history, achievements and future plans. Seated around the conference table (from left to right) are: A. M. Sargent, 1st V.P., ASTE; Joseph Geschelin, Automotive and Aviation Industry; Ralph R. Watts, The Detroit News; Paul Cattey, ASTE Account Executive, St. Claire Advertising Co.; W. J. Frederick, Nat'l Treas., ASTE; George Deery, Automotive News; C. V. Briner, ASTE President; J. D. M. White, Automobile Topics; H. E. Conrad, Exec. Sec'y; A. M. Schmit, Nat'l Sec'y; and W. B. Peirce, 2nd V.P., ASTE; R. B. Powers, Executive Editor, The Tool Engineer; Chester S. Ricker, American Machinist; C. J. Hasse, ASTE office manager; G. N. Loesch, Michigan Manufacturer and Financial Record; Leonard Westrate, Chilton Publications; D. G. Baird, Mill and Factory; and A. H. Ward, Ward's Reports, Inc.

Society Holds Press Conference

A press conference to acquaint the newspaper fraternity as well as the technical press with the nature and activities of ASTE was held at the Book-Cadillac Hotel in Detroit on November 29. The conference served also to introduce to the press the ASTE National Officers and the Society's new Executive Secretary, Harry E. Conrad.

President C. V. Briner gave a comprehensive talk on the origin and growth of ASTE, its accomplishments in recent years and its program for the future.

Representing ASTE at the press conference, in addition to Mr. Briner and Mr. Conrad, were: A. M. Sargent, First Vice-President; W. B. Peirce, Second Vice-President; W. J. Frederick, National Treasurer; A. M. Schmit, National Secretary; and R. B. Powers, Executive Editor of THE TOOL ENGINEER.

Among the newspaper and trade publication representatives present were: Ralph R. Watts, *The Detroit News;* Joseph Geschelin, *Automotive and Aviation Industry;* A. G. Baer and J. D. M. White, *Automobile Topics;* George Deery, *Automotive News;* A. H. Ward, *Ward's Reports;* Dwight G. Baird, *Mill and Factory;* Leonard Westrate, Chilton Publications; George N. Loesch, *Michigan Manufacturer and Financial Record;* Chester S. Ricker, *American Machinist.*

Others present included: Willis Hall, Detroit Board of Commerce; Paul Cattey, the Society's account executive at St. Claire Advertising Company; and Charles Hasse, office manager of ASTE.

A round-table discussion followed Mr. Briner's talk, during which time members of the press expressed unusual interest in Society affairs through the nature and number of their questions. A buffet supper followed.

Frommelt Demonstrates New Carbide Milling

Flint, Mich.—One of Flint Chapter's best meetings took place on November 15, at General Motors Institute, when members and guests heard Dr. H. A. Frommelt, Chief Research Engineer of Kennametal, Inc., Latrobe, Pennsylvania, talk on "High Speed Milling Cutter Performance."

Dr. Frommelt gave a brief history of carbide milling from 1928 to the present day. With slides he showed feeds, speeds and finishes to be expected from this type of milling, pointing out that cutting speeds up to 750 s.f.p.m. have been obtained with carbide tools. The great limiting feature in carbide milling is the power and rigidity of the machine used, he stressed.

As chip clearance assumes great importance in this high speed work, the cutters are specially designed, the speaker explained. The body is heat treated, and the blade slots ground and held to close limits. Blades for the slots are of solid carbide, securely locked in place. All blades may be removed in three minutes and replaced in four, without detaching the cutter from the machine.

At the conclusion of Dr. Frommelt's discussion, the entire group visited the Tool Shop at the Institute where two milling machines were set up with special carbide cutters. The members were impressed with the ease with which both steel and cast iron were removed by carbide milling.

Many of those in attendance presented interesting problems to which Dr. Frommelt gave clear and concise solutions.

Humorist Delights With Travel Tales

Rockford, Ill.—Members of Rockford Chapter entertained their ladies December 6 at Hotel Faust. The event was the Chapter's Annual Ladies Night Dinner.

Upon entering the dining room, each feminine guest was presented with a shoulder corsage. Dinner music was furnished by a string trio.

"Kentucky Colonel Jack Major," humorist, provided the evening's diversion with an account of his travels in Australia and the South Pacific with a U.S.O. unit. His narrative was interspersed with humorous incidents which provoked much mirth. Mr. Major's color pictures of South Pacific animal and bird life concluded a very enjoyable evening.

Above, Dr. H. A. Frommelt (center) of Kennametal, Inc., demonstrates high speed carbide milling to members of Flint Chapter, at General Motors Institute Tool Shop. Dr. Frommelt was technical speaker at the Chapter's November 15 meeting, when he discussed "High Speed Milling Cutter Performance."

At right, Curtiss P. Walton (left), Engineer, C. L. Bendle Metal Cutting Tools, and Cliff L. Bendle (right), owner of the Bendle company and Vice-President of Crobalt, Inc., Ann Arbor, Michigan, have their questions on special milling problems capably answered by Dr. Frommelt.

ASTE President C. V. Briner of Cleveland (standing) tells Fort Wayne Chapter how the Society's plans for the future will benefit Tool Engineers. At head table are (left to right) Secretary Edward K. Burt, National Secretary A. M. Schmit of Toledo, Chairman Milton H. Kline, Mr. Briner, First Vice Chairman Emil W. Mellin (partly hidden), Rudolph E. Esch of Vickers, Inc., technical speaker; and National Director Hayden R. Shearer of Indianapolis.

National Officials Visit Fort Wayne

Fort Wayne, Ind.—On the occasion of its November 14 dinner meeting, Fort Wayne Chapter was thrice honored by the presence of President C. V. Briner, National Secretary A. M. Schmit and National Director H. R. Shearer.

After a report from Director Shearer on the Semi-Annual Meeting recently held in Detroit, and a few remarks from Secretary Schmit, President Briner spoke on the "Operation of National Headquarters and Future Plans of the National Organization for the Promulgation of Tool Engineers." His talk included a review of the growth of the Society from a small local Chapter at Detroit to the present membership in excess of 18,225 members.

In predicting the future of ASTE, Mr. Briner stated that the organization has passed the "growing pains" stage, and, with the development of plans and projects now under way, it will continue to gain respect and admiration in engineering circles.

President Briner referred to the untiring efforts of the National Officers and Committee Chairmen in the reorganization and extension of Society activities.

Rudolph E. Esch, Machinery Equipment Manager, Vickers, Inc., Detroit, and technical speaker for the meeting, discussed "Hydraulic Transmission of Power." Mr. Esch illustrated his talk with slides and models of hydraulic motors and controls.

Approximately 85 members and guests attended the meeting at the Chamber of Commerce.

Georgia Tech Professor Heat Treating Speaker

Atlanta, Ga.—Care in obtaining the proper temperature for heat treating metals was one of the points emphasized by Prof. O. M. Harrelson, head of the Metallurgical and Welding Department, Georgia School of Technology, and principal speaker at Atlanta Chapter's December 5 meeting in the Ansley Hotel.

Though his topic, "The Manufacture of Iron and Steel, and Heat Treatment," is large in scope, Prof. Harrelson demonstrated remarkable ability in selecting the "meat" of the subject, making this meeting one of the highlights among programs presented by the Chapter.

New members welcomed included F. V. Crowe, H. K. Grant, C. S. Blaylock, Dwight Hollowell, Paul Roper, and J. T. Henry who transferred from Philadelphia Chapter.

Tooling Ups Production—Workers Loaf

Newark, N. J.—Jigs and fixtures designed by Tool Engineers have made it possible for an operator to loaf half the time and still get out his quota of production, according to Frank O. Hoagland, Master Mechanic, Pratt & Whitney, Div. Niles - Bement - Pond Company, Hartford, Connecticut, and speaker at the November 13 meeting of Northern New Jersey Chapter.

F. O. Hoagland

By way of specific example, Mr. Hoagland mentioned that in the manufacture of rifle barrels with the original equipment, maximum production per man-day was 16 pieces. When new tooling was installed, it was expected that production would double, but the operators decided that a 50% increase was adequate. Maximum production was thus 24 barrels. The job was then turned over to a new group with no previous experience, and output immediately rose to 40.

Turning then to his main topic, Mr. Hoagland outlined the history of precision measurements from the earliest days down to the acceptance of the standard French meter and the Congressional decision to fix the length of the standard inch as 25.4 mm. He then traced the development of the jig borer, and pointed out the necessity of proper dimensioning of drawings for parts to be machined on this equipment.

Locating all holes from the top and left-hand edges, he explained, makes it possible for the operator to place the drawing on the machine table and duplicate dimensions directly without making time-consuming calculations.

Emphasizing the necessity for proper temperature control, the speaker showed how the use of newly-designed duralium-copper parallels for supporting work on the jig borer table would conduct heat from the work and assure increased accuracy.

The talk was illustrated with numerous lantern slides of measuring and jig boring equipment. Methods were shown for setting up work on the table for the boring of angular and compound angular work with absolute precision. A question period followed, lasting over a half hour.

Over 100 members and guests were present for dinner, with a total of some 250 at the meeting—one of the biggest attendances recorded by the Chapter.

Situations Wanted

HONORABLY DISCHARGED VETERAN desires position as tool designer in the United States. Ample engineering background, including 1½ years aircraft tool designing; 2½ years topographical and construction engineering; 1¼ years chemical engineering; 2 years mining engineering; 3½ years mechanical engineering in college. Excellent references. Write Box P, American Society of Tool Engineers, 1666 Penobscot Bldg., Detroit 26, Mich.

New Consumer Goods Precision Broached

Baltimore, Md. — Kenneth N. Macomber, Chief Service Engineer for The Lapointe Machine Tool Company, Hudson, Massachusetts, gave a comprehensive talk and showed two interesting colored films on the history and accomplishments of broaching before Baltimore Chapter's December meeting in the Engineers Club.

K. N. Macomber

Wartime developments in precision broaching will solve many problems in the production of consumer goods, Mr. Macomber declared. Such necessities as motor blocks and connecting rods for automobiles and airplanes, household flatiron bases, wrenches of all sizes and descriptions, used for the smallest nut on a sewing machine to the largest on a two-hundred ton milling machine, are all being precision broached, he said.

Jet propulsion, he pointed out, owes much of its progress to the precision machining accomplished by broaching equipment. An interesting project now in production, Mr. Macomber related, is the segment gear for the household washing machine. Heretofore, this gear was made somewhat haphazardly on a milling machine, but with the exact tolerances achieved by broaching, the housewife is guaranteed precision operation of her washer. Many other outstanding jobs of vital interest to every consumer are now being worked out by broaching, according to the speaker.

Mr. Macomber conducted a question and answer session, after showing colored films on broaching, giving valuable information on problems confronting some of the Chapter members.

Curtis and Briner Guests At ASM-ASTE Meeting

Boston, Mass.—The local Chapters of ASM and ASTE collaborated in a joint dinner meeting at Hotel Bradford, November 8, with ASTE Past President Frank W. Curtis as the featured speaker.

Mr. Curtis, who is Consulting Engineer for Induction Heating Corporation, New York City, and a National Director of ASTE, gave one of his splendid talks on "High Frequency Induction Heating," a subject on which he is a recognized authority. His papers, articles and books, dealing with induction heating, are well known in industry.

After thoroughly discussing mechanical devices and equipment, tooling and setups for short runs and automatic production on hardening and brazing, Mr. Curtis showed colored motion pictures which effectively illustrated his remarks.

ASM Past Chairman Harry B. Parker, Metallurgist, of Tubular Rivet and Steel Company, Wollaston, gave a gadget talk on "Some Corrections on Fatigue Failures." Mr. Parker is also a member of Boston Chapter, ASTE.

The anti-blackout suit was demonstrated and explained by its co-inventor, Henry W. Wilder, Chief Inspector of Heald Machine Company, Worcester, and member of ASTE and ASM. John L. Morosini, another ASTE member, assisted Mr. Wilder in the demonstration.

ASTE President C. V. Briner extended the Society's greetings to the 350 members and guests of both organizations. Ray Sault, Chairman of the Boston ASM Chaper, spoke briefly, outlining his society's past achievements and future plans.

An afternoon exhibit and demonstration of induction heating equipment, in the Boston Edison Company's high frequency electric heating laboratory, preceded and supplemented the evening's program.

Cleveland Issues Roster

Cleveland Chapter has published an attractive roster for the 1945-46 season. The book contains, in addition to the names and addresses of members, a cross-listing by companies, the personnel of Chapter committees, and an Honor Roll of Armed Service members.

Chemist Shows Plastics Molding Processes

St. Louis, Mo.—J. Kenneth Craver, Research Chemist, Monsanto Chemical Company, St. Louis, in practical layman's language presented a lecture on plastics, illustrated with a film, "The Shape of Things to Come," at the November 1 meeting of St. Louis Chapter. The motion pictures, showing various types of plastics and molding dies, were followed by a question and answer period.

J. K. Craver

Mr. Craver specializes in plastics, plasticizers, and catalytic hydrogenations. In addition to his work at Monsanto, he is a member of the St. Louis faculty of Plastics Institute. The Plastics Club of St. Louis, with a membership of 150 persons interested in this field, was founded by Mr. Craver.

Van Ausdall Organizes Development Firm

Liberty, Ind.—Carl Van Ausdall has started a tool and machine design business known as "Van's Service." This service includes design of product (assembly and detail), drawings for manufacture, product development, design of tools, and method of manufacture.

C. Van Ausdall

Designing projects are already under way, and the building of models will begin as soon as equipment can be acquired.

Mr. Van Ausdall was recently connected with the Engineering Service and Machine Company of New York City. Prior to this association, he served as tool engineer and chief draftsman for the Lewis Precision Company, and also was employed by the Sperry Gyroscope Company.

A former member of Greater New York Chapter, ASTE, Mr. Van Ausdall has transferred to Richmond Chapter.

Schiller Earns Degree Of Professional Engineer

New York—A Professional Degree in Engineering has been conferred on J. D. Schiller, Engineering Department Chief, Western Electric Company, Jersey City, New Jersey, by Cooper Union Night School of Engineering.

J. D. Schiller

Mr. Schiller, Chairman of Greater New York Chapter, ASTE, earned his degree by attending evening classes while carrying on his daytime war production responsibilities and executing the duties of the various offices he has held in his Chapter.

While at night college, he was Vice-President of the graduating class and Chairman of the American Society of Mechanical Engineers Student Chapter. A prize for an outstanding record in Mechanical Engineering was also awarded him by ASME. He is a B.M.E. graduate of the school's 1932 class.

For the past five years he has been associated with Western Electric Company in the Jersey City and Kearney plants, having complete responsibility for several manufacturing projects. Since 1942 he has been in charge of manufacturing engineering.

Previous business connections include service with E. W. Bliss & Company, Brooklyn, as Tool Designing Section Chief in the tooling program for naval torpedoes; machine and tool designing for Conmar Products Corporation, Bayonne, and Strauss Fasteners, New York City, manufacturers of slide fasteners and related machinery; and several years as machinist, millwright, and tool and die maker. In the latter capacity, he was employed by Sperry Gyroscope Company and American Can Company, Brooklyn, and Aeromarine Instrument Company, Bronx, New York.

A charter member of Greater New York Chapter, ASTE, Mr. Schiller served several terms as Standards Chairman, Secretary and First Vice-Chairman before his election this year to the chairmanship of the Chapter.

Time permitting, he plans to continue studying for a Ph.D. in M.E.

When Boston Chapter met with ASM November 8 in the Hotel Bradford, 350 members and guests of both Societies assembled to hear ASTE's genial Past President and National Director, Frank W. Curtis, speak on "High Frequency Induction Heating." The gathering was also distinguished by the presence of ASTE President C. V. Briner.

Standing at the speaker's table are local and national officials of both organizations. Left to right: Standish S. Rowe, Boston ASTE Membership Chmn.; James L. Faden, ASM; Paul F. Fields, ASTE; Howard Handy, Boston ASM Secretary; Ray H. Morris, Past President, ASTE; W. W. Young, National Director, ASTE; John Ryneska, 2nd Vice-Chmn., ASTE; Messrs. Briner and Curtis, Arthur A. Nichols, Chmn., ASTE; J. B. Savits, Boston ASTE Program Chmn.; Henry W. Wilder, ASM, speaker; Harry B. Parker, Past Chmn., ASM, and gadget speaker; Prof. John Norton of Massachusetts Institute of Technology, and Past Chmn., ASM; Prof. John Chipman of M.I.T., and National Trustee, ASM; Ray Sault, Chmn., ASM; Henry Richards, Past Chmn., ASTE; and James Moran, Research Engineer.

Press Brake Versatile

Cedar Rapids, Iowa — The largest attendance recorded by Cedar Rapids Chapter heard A. G. Baumgartner, Mechanical Engineer, Cincinnati Shaper Company, deliver an illustrated lecture November 7 on "The Press Brake in Sheet Metal and Plate Work." Forty members and 80 guests of the young Chapter were present at the Hotel Roosevelt dinner meeting.

The versatility of the press brake in handling a wide variety of forming and punching jobs, as explained by Mr. Baumgartner, was very impressive. Of especial interest was his description of the methods used in tooling up for diversified problems.

As coffee speaker, John J. Wagner, past president of the Cedar Rapids Real Estate Board, and prominent in state and national real estate circles, outlined the principal reasons for the present national housing shortage. He pointed out that high production methods and a building trades training program will be required to properly alleviate the situation.

Before the technical session, the audience had an opportunity to inspect exhibits furnished by the Cincinnati Shaper Company and the Frederick Post Company.

Cleveland Show Hotel Reservation Forms Should Be Secured From Nat'l Hdqtrs. *Now*

Thread Grinding Found More Efficient

South Bend, Ind.—M. S. Gjesdahl, Research Engineer, Landis Machine Company, Waynesboro, Pennsylvania, addressed South Bend Chapter at their November meeting, on the subject of "Centerless Thread Grinding." Mr. Gjesdahl gave a short summary of typical grinding equipment and then proceeded to describe the development of centerless thread grinding machines.

M. S. Gjesdahl

One of the distinct advantages of thread grinding, the speaker declared, is that the threads are formed on the hardened bar and there is no danger of the distortion common in former processes where the part was first threaded and then hardened. Among other superiorities of this process are the very smooth finish obtainable and the more nearly perfect shape of the thread. Parts under $\frac{5}{8}$" are ground from the solid bar in one pass through the machine, while larger parts are either pre-threaded or ground more than once.

The grinding wheel, he explained, is kept to the right shape by a wheel crushing attachment mounted over the top, ready for use when necessary. Brass screws can be ground without any crushing, as brass has little or no wearing effect on the wheel. Small screws of the number sizes can be ground at astonishingly high speeds—as many as 2000 to 3000 per hour.

Mr. Gjesdahl used charts to describe the theory of thread forming by tilting the regulating wheel to twice the helix angle of the thread. At present, experiments are being conducted in the development of precision Acme threads by first cutting an .080 depth, hardening the thread, and then centerless grinding the last .010, he said.

National Director H. R. Shearer of Indianapolis spoke briefly, reporting on the Society's recent Semi-Annual Meeting at Detroit.

Jackson Chung, the coffee speaker of the evening, described industrial developments in China, which thus far have been limited to treaty ports. In order to catch up with the rest of the world, Mr. Chung stated, China would have to inaugurate an industrial policy whereby heavy industries would be state-owned.

A program similar to Russia's five-year plan would be launched, Mr. Chung indicated. The services of foreign engineers and the purchase of machinery would have to be financed by intensive sales of agricultural products. Another requirement for China's industrial expansion would be the establishment of a stable government which could insure the repayment of foreign loans. China is now sending students to the United States to learn our methods for application to its new industrial order, the speaker told his audience.

Record attendance of 120 turned out for Cedar Rapids November 7 meeting. Technical speaker was A. G. Baumgartner of Cincinnati Shaper Company who discussed "The Press Brake in Sheet Metal and Plate Work." Chairman John Speck (standing, in lower photo) calls meeting to order. At speaker's table (left to right) are Treasurer R. A. Hruska, Dan Avery, Frederick Post Company; Secretary John L. Stark, John J. Wagner, Cedar Rapids Real Estate Board, coffee speaker; Mr. Baumgartner, First Vice-Chairman M. J. Fitzgerald, Entertainment Chairman Bruce Dew, and Second Vice-Chairman J. L. Sealy.

"We have the greatest productive science in the world, but unfortunately business is often too busy fighting government to work with science," Dr. Hilton Ira Jones (upper left) tells Elmira Chapter in his lecture, "Peeps at Things to Come." Dr. Jones, a noted chemist, was the speaker at the Chapter's Fourth Annual Ladies Night held November 5 in Mark Twain Hotel. Miss Barbara Jane Brown (center), one of five finalists in the "Voice of Tomorrow" contest at Philadelphia, entertains with vocal selections. Right, Chairman George N. Morceau presents a Victory Bond to Mrs. Ivan Lake, winner of the door prize. Officers and guests at speakers' table (lower photos) are, left to right, Secretary and Mrs. Floyd B. Allen, Miss Wilma Kylor, Mrs. Edward Stachel and Second Vice-Chairman Stachel; Mrs. Burr Jones and First Vice-Chairman Jones, Dr. Hilton Ira Jones, guest speaker; Chairman and Mrs. George N. Morceau, Past Chairman and Mrs. J. R. Blank, Past Chairman Dolph Kylor, and Treasurer and Mrs. James F. Deegan.

Technical Editor Guest Speaker

Hamilton, Ont.—The 41st regular dinner meeting of Hamilton Chapter was held at the Royal Connaught Hotel on November 9.

Head table guests introduced by Chairman Harry H. Whitehall included L. G. Singer, former Director and National Officer; E. A. Greer, recently transferred to Toronto, and A. E. (Andy) Rylander, technical editor of THE TOOL ENGINEER.

B. T. Anderson

A. E. Rylander

Called upon for a short talk, Mr. Rylander asked for fullest support of local and National Officers. He commented on the coming Exposition, the "Tool Engineers' Handbook," and ASTE Directory now in process, and reported on the progress of THE TOOL ENGINEER.

Technical speaker of the evening was B. T. Anderson, Chief Electrical Engineer, Sundstrand Machine Tool Company, Rockford, Illinois, who spoke on the "Application of Electronics to Machine Tools." Mr. Anderson's lecture was profusely illustrated with slides showing the use of various electronically-equipped machine tools in solving special machining problems.

Scientific Discoveries To Revolutionize Life

Elmira, N. Y.—Dr. Hilton Ira Jones, eminent scientist, gave 250 members of Elmira Chapter and their guests "Peeps at Things to Come," in an address before the Chapter's Fourth Annual Ladies Night at Mark Twain Hotel, November 5.

Dr. Jones fascinated his audience with his demonstrations of laboratory magic in the creation of comforts and pleasures for the near future. He displayed plastic piping that can be pulled through partitions like electric cable—that is elastic enough to withstand freezing without bursting; glass fabrics "that will last as long as you live"; and mattresses of "bubble fill" to make slumber like sleeping on a cloud.

Among other wonders he predicted were a new plastic so transparent that a newspaper could be read through a piece 36" thick; windows of plastic that admit 98% of the sun's ultra-violet rays; springs for dollar watches made of tempered glass which never changes size or shape under extremes of heat and cold; a starch for clothes that outlasts the material; comforters of glass that weigh only a pound and a half; Nylon hosiery that needs no drying—only a snap after washing and it's ready to be worn again; and a new tough adhesive with which shoe parts can be fed into a machine and turned out as complete uppers.

Dr. Jones urged closer cooperation between business and science in order to expedite these marvels to the consumer. "With enough encouragement from business, science will revolutionize life as we know it today," he promised.

One of the most instructive and inspiring programs ever presented by the Chapter, Dr. Jones' lecture was immediately followed by requests for a return engagement next year.

Dinner music was provided by the Talitha Botsford Trio. Miss Barbara Jane Brown, one of five finalists in "The Voice of Tomorrow" contest held in Philadelphia this year, rendered several classical and operatic selections. A rosebud was presented to each lady present.

Hage Takes Over Tool Company

Toledo, Ohio—Albert Hage, General Manager of Hage Industrial System, has acquired the management of the Perfection Tool and Manufacturing Company of this city.

Albert Hage

Both companies design and process programs, and manufacture tools (including special cutting and thread ground tools), dies, jigs, fixtures, gages, and parts.

Opened a year ago, the Hage plant has progressed rapidly, permitting the recent acquisition of the Perfection Company which is known as the Industrial Service Division.

Before becoming a tool manufacturer, Mr. Hage managed the S & B Tool Company and A Tool & Gage Company, Detroit, for a year. For the seven previous years, he functioned as Purchasing Engineer for Spicer Mfg. Corporation. Earlier, he served as Inspector at Electric Auto-Lite Company and Willys-Overland Motors, Inc.

He received his technical education at Massachusetts Institute of Technology and the University of Toledo. An active member of Toledo Chapter, Mr. Hage has held office as Treasurer and as Chairman of several committees.

Hard Work, Formula For Success

Toronto, Ont.—If you can't open a tool shop of your own, get a job where you think opportunities exist; then study and work so hard that the boss, realizing your value, will give you the business rather than let you quit! This advice was passed on to Toronto Chapter by Neil P. Petersen, President of Canadian Acme Screw & Gear, Ltd., and York Arsenals, Ltd., in his address on "Opportunities," delivered December 10 at the Chapter's Annual Executives Night held in Malloney's Art Gallery.

N. P. Petersen

Commenting on the variety of fields open to the ambitious, clear-thinking youth of Canada, in industry, on the farm, in the mines and in the field of distribution, he held his audience deeply interested and highly amused by dwelling on episodes in his own business career, which rivalled fiction.

Born in Denmark, Mr. Petersen followed the sea, then eventually settled in the United States where he served his apprenticeship as a toolmaker. He reached his present position, as he put it, "the hard way." He insisted that anyone who is willing to work can be a success.

Speaking on the Unification of Engineering Standards pertaining to the Screw Thread Conference, Mr. Petersen, a Canadian delegate to the Conference, discussed the variations of thread forms and the difficulties involved in arriving at a satisfactory standard agreeable to all the countries involved.

Suitably-inscribed gavels were presented to all Past Chairmen and to Chairman R. Eric Crawford by Walter W. Appleton, First Vice-Chairman of the Chapter.

An audience of 145 members and friends attended the function.

* * *

Addressing 160 Chapter members, November 12, R. A. Schafer, Development Engineer, National Automatic Tool Company, Richmond, Indiana, held their attention with a highly interesting topic, "Multiple Spindle Drilling and Tooling Techniques."

R. A. Schafer

Mr. Schafer stressed that single spindle drilling is long since dead as far as production is concerned. With slides he showed methods and tooling for multiple spindle drilling. He compared production figures and methods with old single spindle methods, impressing his audience with his thorough knowledge of the subject.

Ladies Night Program Marks 4th Anniversary

Fond du Lac, Wis.—Members of Fond du Lac Chapter entertained their ladies at dinner in Hotel Retlaw, November 9, on the occasion of the Chapter's Fourth Anniversary program.

Principal speaker was Fred L. Holmes, lawyer and author, who spoke on "Old World Wisconsin," illustrated with colored slides showing the contributions made by various foreign groups to the state's cultural heritage. Included in the travelogue were Wisconsin settlements of Belgian, Swiss, German, Polish, Cornish, Scandinavian and Russian immigrants.

Mr. Holmes was presented by W. E. Rutz, Vice-President and Works Manager, Giddings & Lewis Machine Tool Company, who was the original organizer of the Chapter. Hotel Retlaw was the scene of the first meeting of a group of engineers, assembled at Mr. Rutz' invitation, who subsequently became charter members of Fond du Lac Chapter.

On display, under an arch of flags of many nations, was the ASTE National Membership Trophy twice won by Fond du Lac Chapter.

Chairman Gideon Kane of Green Bay introduced guests from surrounding communities, Nashville, Tennessee; and Mexico. Each feminine guest received a corsage. Musical entertainment was presented by the Elks' Glee Club.

Describes Manufacture Of Carbon Electrodes

Kansas City, Mo.—The manufacture of electrodes to deliver the thunderbolt electrical charges necessary to melt and smelt metals was well presented by Earl L. Dibble, Assistant Division Manager, National Carbon Company, speaking before Kansas City Chapter, December 5, in the Pine Room of the Union Station.

Mr. Dibble's remarks on "Carbon—Black Treasure" supplemented a Kodachrome film of the same title, telling the story of the engineering, research and development which have made carbon an irreplaceable industrial tool in electrothermal and electrolytic applications.

Carbon electrodes, such as are used in heating big steel furnaces down to those providing the filament for sun lamps, were shown in motion pictures. Processing of the coal was depicted from the time it arrives in cars, is sampled, heated, extruded through dies, then inspected and machined to close tolerances.

After screening the film, Mr. Dibble answered various questions bearing on the subject.

Lowell Johnston, Chief Production Engineer, Aireon Manufacturing Corporation, and coffee speaker for the evening, gave a demonstration of "Black Light" and fluorescent materials. Mr. Johnston rendered luminous signs and other objects in his display equipment, by activating the various materials with black light. Many of the ways in which black light was used by the Armed Forces during the war were explained by the speaker to the 53 members and visitors present.

Fond du Lac members and their ladies return to Hotel Retlaw, scene of Chapter's first organization meeting, to celebrate Fourth Anniversary of the group which has twice won the Society's Membership Trophy. Cup may be seen displayed beneath an arch of flags, in upper left center of photo.

"Crush Grinding," as presented by C. J. Linxweiler and R. Y. Moss of The Sheffield Corporation, attracted 245 engineers to Philadelphia Chapter's November 15 meeting in the Engineers Club. Mr. Linxweiler, at the left, and Mr. Moss, at the right, are shown addressing the group. In the center is a group of new members at one of the special tables arranged by Membership Chairman Arthur F. Diamond. Each recently-elected ASTE'er received a boutonniere.

Crush Grinding Symposium

Philadelphia, Pa. — "Crush Grinding" was the technical topic discussed by C. J. Linxweiler, Manager, Machine Tool Division, and R. Y. Moss, Production Engineer Manager, The Sheffield Corporation, Dayton, at the November 15 meeting of Philadelphia Chapter.

Mr. Linxweiler sketched the history of Crush Grinding which, he claimed, originated in the distant past and was finally lifted from the rut of antiquity by the Tool Engineer. This method of dressing wheels, which has been used in Europe since the early '30's, is now moving ahead rapidly, he stated.

Crush grinding, he explained, is done with the aid of a formed roll which is crushed into the grinding wheel, either by power, manually, or by a feed on the crusher roll. This form is then transferred to the work piece by means of plunge, transverse, or by transverse and plunge combined feeds.

Two hundred and fifty feet per minute is the speed recommended for crush forming of the grinding wheels. This can be done by either dry or wet methods, but the use of regular thread grinding oil makes sharper corners and better fillets possible.

Another interesting feature in Mr. Linxweiler's talk was the comparison of a wheel which had been diamond dressed with one dressed by the crush method. Cutting points of the latter were much sharper and more numerous, while the diamond dressed grains were flat on the cutting points. This made the crush dressed wheel cut faster, cooler, easier, and last longer.

Silicon carbide and A1 oxide with vitrified bonds, of grades J & P, are used for crush grinding wheels, grain sizes up to 400 having been used successfully. Best results have been secured from 18-4-1 high speed steel, Mr. Linxweiler commented.

Mr. Moss continued from this point, detailing actual work problems and their rates. He recalled one problem where two and one-eighth inch, sixteen threads to the inch were ground to a class three fit at the rate of forty pieces per hour.

He warned against trying to crush grind for a straight side, as an angle on the side of the wheel gives more satisfactory results. Slides showing formed and threaded shafts, worms, parts for propellors and jet engines supplemented Mr. Moss' remarks.

In the subsequent general discussion period, it was brought out that a grinding wheel must maintain its sharp corners and fillets, the structure of the wheel must be open for chip clearance and fast cutting, and that gashing crusher rolls provides a channel for chips to wash out while crushing the wheel.

Answers given by Mr. Moss to other questions asked by the audience indicated that crush grinding is practical on a surface grinder; that 100 pounds pressure per square inch of wheel face is required to crush wheels; that crusher rolls of from three to five inches in diameter give the best results; and that grinding costs compare favorably with milling.

At the conclusion of the forum, the members inspected the display of crush ground specimens which the speakers exhibited.

Dinner was served by the Engineers Club to 188 members and guests whose numbers were increased to 245 for the technical session. Special tables were arranged by Membership Chairman Arthur F. Diamond for the 55 new members who were present.

Emphasizes Importance Of Good Tooling

Syracuse, N. Y.—"The Importance of Good Tooling" was stressed by Walter M. Smith, Eastern Sales Manager for Bryant Chucking Grinder Company, Springfield, Vt., and speaker at Syracuse Chapter's dinner meeting held December 11 in the Onondaga Hotel.

W. M. Smith

At the conclusion of his splendid talk, Mr. Smith showed an excellent color film, detailing the tooling of internal grinders.

Keen interest was exhibited in the samples of work done on these machines, displayed by the speaker.

Thirty-eight members were present for the dinner, while 62 participated in the meeting.

York State Bowlers Brave November Blizzard

Rochester, N. Y.—Despite bad traveling conditions induced by a heavy snow storm, 147 members and friends of Rochester Chapter had an enjoyable evening November 30 at the Chapter's annual bowling party in Eagles Hall. Prize for high bowling score of 201 went to Joseph Mattula. Adolph Batjer of the Star Tool Company won the door prize of a set of DoAll Tool Maker's Gage Blocks. Through the efforts of Chapter Treasurer Fred Bittner, the Commercial Controls Corporation was well represented, and this group fared very well in the matter of prizes.

A buffet luncheon was served at the conclusion of the bowling.

Joseph Manuele (right), Director of Quality Control, Westinghouse Electric Corporation, answers questions for members of Rochester Chapters ASM and ASTE, following a recent joint meeting of the two organizations. Mr. Manuele, the technical speaker, discussed "Control of Quality During Manufacture and Its Effects on Production and Costs." At left are Elmer Abell, ASM member, and Milton Roessel, Second Vice-Chairman, Rochester Chapter, ASTE.

Educational Service Meeting Feature

San Diego, Calif.—A comprehensive library of tooling data, reference books, magazines, and technical slides is available to San Diego members at Chapter meetings. Collected and catalogued for educational purposes by Education Chairman A. C. Arends, this library covers all phases of tool engineering and is indexed for quick and easy reference.

Chairman Arends, a Tool Designer for Consolidated Vultee Aircraft Corporation, has been compiling this information for many years. For the past four years, he has been using it in his tool design lectures at the San Diego Vocational School. This rich store of material, combined with his method of teaching, has made his classes completely successful in training young men for the tool design profession. Many young members of San Diego Chapter entered this field through instruction received from Mr. Arends.

In order that everyone in the Chapter may utilize this material, Mr. Arends sets up an educational display and information service at each meeting. A well-prepared bulletin board announcing Chapter news, a listing of selected articles from current technical magazines, and a bibliography of foremost approved reference books are exhibited, along with a liberal display of manufacturers' literature.

Used technical magazines are available on an exchange basis. Members and guests may borrow any they choose, provided they contribute an equal number of their own periodicals. In this manner, members may acquaint themselves with the various trade papers and keep informed on current technical news.

One of the first to appreciate the value of visual aids in teaching, Mr. Arends has assembled more than a thousand technical slides, illustrating nearly every conceivable phase of tool engineering. This collection has been acquired as a hobby.

A teaching guide, "Fundamentals in Tool Design," begun by Mr. Arends is intended as an aid in vocational training and as a reference book.

Obituaries—

Carl H. Sinn

The death of 2nd Lt. Carl H. Sinn, AAF, previously listed as missing in action, July 19, 1944, was later confirmed by the former German government, according to information recently received at National Headquarters.

C. H. Sinn

Lt. Sinn, a member of Philadelphia Chapter, ASTE, was killed in action while flying on a mission over France, the official notification states. Trained as a navigator bombardier, after entering the Army Air Force in November of 1942, he was commissioned a 2nd Lieutenant. In April of 1944 he went overseas where he served until his death.

Born at Philadelphia, he attended Olney High School, in that city and completed several evening school and correspondence courses. He was a student in the Tool and Die Designing class at Spring Garden Institute, Philadelphia.

A first-class machinist, he had had a variety of experience at Fleetwing Aircraft, Frankford Arsenal and in the aircraft experimental laboratory of the Philadelphia Navy Yard where he was employed when he entered the service.

* * *

A. C. Waldvogel

A. C. Waldvogel, owner, A. C. Waldvogel & Company, St. Louis, Missouri, recently passed away at the age of 51.

Mr. Waldvogel was born in Hamilton, Ohio, in 1893, and acquired his technical education at Ohio State University. After serving his apprenticeship, he was employed in designing tools and machines for a number of Ohio manufacturers.

During the first World War, he was in the Experimental Department of Air Service at the Armorer School, Wilbur Wright Field, Dayton. In 1921 he went to St. Louis, joining the Clyne Engineering Company. The latter part of the following year he went into business for himself, manufacturing various types of shovels.

With the exception of a five-year period when he worked for Curtiss-Wright, and was associated with Atlas Tool & Mfg. Company in the production of his coffee roaster, he operated his own company. In 1942 he organized the engineering business bearing his name, in which he was engaged at the time of his death.

Mr. Waldvogel was a member of St. Louis Chapter, ASTE.

Predicts Magnesium In All Vehicles

Dayton, Ohio—One of Dayton Chapter's most interesting meetings of the year was held November 12 in the Biltmore Hotel, with a well-presented program on "Magnesium" sponsored by Hills-McCanna Company, Chicago; Dow Chemical Company, Midland, Michigan; and Revere Copper and Brass, Inc., New York City.

Dan Moll, Vice-President and Treasurer of Hills-McCanna Company, Foundry Division, spoke on the development of the magnesium industry and the consequent price reductions as "know-how" in handling and fabricating the metal increased. The industry is now able to produce all the magnesium immediately required and to expand as rapidly as a potential market materializes, Mr. Moll declared.

The part Dayton has played in building magnesium consumption to previously undreamed of tonnage, for A.A.F. purposes, was accented by Charles Kuthe, Technical Advisor, Revere Copper and Brass, Inc., in his talk on the uses of this material. Mr. Kuthe predicted that magnesium would soon be employed in the manufacture of all transportation vehicles.

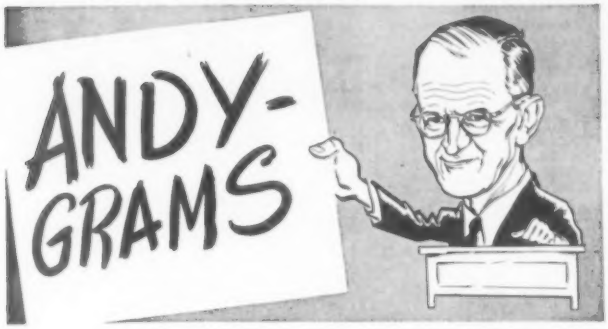
"Magnesium Alloys and Properties" were described by Thomas Caldwell, of the Cleveland office of the Dow Magnesium Division. The fire hazard associated with the fabrication of magnesium was minimized in Mr. Caldwell's demonstration of gasoline burning in a .040" stamped plate which did not ignite.

The sound film, "Magnesium—The Miracle Metal," showed in detail the steps in preparing ingots and subsequent castings. Precise control of processes was evident in the specimens for laboratory test, as well as in the production record.

An accompanying display, exhibited by the three sponsoring companies, included castings, forgings, extruded shapes, and varied products embodying magnesium.

A novel feature was the weight-guessing contest in which the ASTE'ers attempted to estimate the combined weight of blocks of magnesium, aluminum, cast iron, copper, and a pretty girl from Sheffield Corporation. A Victory Bond was to be awarded the best guesser.

Education Chairman A. C. Arends of San Diego Chapter (left) suggests helpful technical literature to Chapter members. Photo shows part of the educational display which he sets up at each meeting.



SINCE COMING on the job, I've acquired a feeling for the cook who, contending with late deliveries and watching many things at once, falls short of an ideal a/c the soup may be thin or because a senescent egg somehow slips into the custard. I've also come to understand why a cook likes to dine out, apropos which—like the rest of you—I get a lot of pleasure out of the A.S.T.E. News, edited by our up 'n' coming pin-up gal, Miss Doris Pratt. In fact, reading the News is about the only way I can keep up with Society doings, these days.

Currently, Doris is running a series on our past presidents, (O. B. Jones, historian) a rather trying chore a/c some of the Nine Old Men emulate the taciturn clam besides coming through—if at all—'way past the deadline. Come his turn, she asked me to use my persuasive powers on Frank Shuler and, being an obliging guy, I got him on the phone. The conversation, in gist, ran something like this:

"Frank, we want to run a story about you." "Go ahead." "But you haven't sent in the material." "Why me? I'm not a writer. Want me to brag about myself? You know what I've done." Yes, I know, having been a Director when Frank was Prex, but Doris came on the job long after that and would have to dig the material out. And time, to our busy News editor, is something like Nylon stockings—there just ain't any.

As for bragging, anything that Frank might say, about himself, would probably fall far short of accomplishment. And that goes for most of our officers, past or present. The idea is to provide a skeleton outline on which to build; between us, we'll put flesh on the bones. Anyway, I half promised Frank that I'd call on him, but, finding that I can't make it—and rather than have an aching void in the sequence—I'll give you the highlights of events during his administration. Can't leave a *Master of Mass Production* out of the picture, especially as he helped to put the A.S.T.E. into long pants.

During Frank's term of office, Jim Weaver (then a Director) had casually proposed a *tool exhibit*, to be held in connection with the next ('38) Annual meeting, and I had as casually seconded the motion, which carried. Ford Lamb, who had recently been appointed Exec. Sec'y, expanded on the idea and, during the fall of '37, proposed a Tool Show on a scale that all but took our breaths away. Some of the boys were dubious about our ability to sell the idea to exhibitors; while others protested on grounds of a limited treasury. And was it limited!

I looked at Frank, who was quietly taking in the pros and cons, and sensed that, like myself and several others, he was strongly for it. I said: "It'll go over if we all get behind it and push." There were nods of approval, and Frank, who is as short on words as he is long on action, settled it: "Well then, let's go!" We did, and the Show packed Convention Hall and made industrial history. It also projected the A.S.T.E. into the first division among engineering associations, and from there into definite leadership. As for the exhibitors, the most were so enthusiastic that, when the next Show was announced, there was immediate clamor for space. And now, the A.S.T.E. is preparing for the *New Era Exposition*, to be bigger and better than ever before.

It's been that way with about everything the Society has done. Progress!—and a better and broader service to our members and to the industries they serve. Take this new A.S.T.E. Directory f'instance, that Wayne Kay is ch-maning. It's an *exposition* in itself, only, the "exhibitors" will be advertisers who will present their wares to a year 'round attendance that, at date of writing, is soaring to the 19,000 mark. And plenty of the 19,000 are key men who either buy directly or who specify what is to be bought; besides, all members in the States, Canada and abroad will have instant access to products advertised and the nearest field representative. Taken as a whole, it is my belief that, like all A.S.T.E. projects, it will prove mutually advantageous to all concerned. Let's all get behind it!

Somehow, the old saw about the guy who builds a better mouse trap applies patly to the A.S.T.E. Only, our "mouse trap" includes about everything manufactured on a mass scale, and truly our boys have contrived to make it a better gin than the world has ever known before. And, the world is coming to our door, as attested by a growing interest in England, Sweden, Russia, and the Latin lands to the south—yes, and even Africa and Australia.

Especially, the Army and Navy has come to know our worth. In this connection, 3rd V. P. Tom Orchard attended a recent meeting of Potomac Chapter, in Washington, when Rear Admiral W. A. Kitts spoke on "Naval Ordnance." In his talk, Adm. Kitts brought out that the Navy Ordnance Dep't had come to realize that so-called professional or Ordnance engineers are not familiar enough with tooling and production to design new Ordnance with an eye to manufacturing. As a result, two grades of engineers are to be considered in future set-ups—Ordnance engineers, as at present, and practical engineers whom, it is expected, will be drawn from such organizations as the A.S.T.E.

From one thing to another, we read a great deal about juvenile delinquents, these days, but very little about the great majority of kids who, healthily occupied, make up our solid juvenile citizenry. Like the lad who, one evening, rang our door bell and handed the (?) partner a typed "business card": STOP—LOOK! WE WILL: Empty ashes . . . 10c, Rake leaves . . . 25c, Wash windows . . . 03c per pane, Go to store . . . 10c, AND ODD JOBS. FOR SERVICE CALL UN. 1-1785. KELLY BROTHERS. (My personal guess is that the Kelly Brothers will get along in the world.)

From Bill Young, Boston, a newspaper clipping telling about a Detroit gal who invented a permanent shave. Two X-Ray treatments, and you're beardless for life. Well, I'm here to tell the world that it works. Last year, I had a series of X-Ray shots for a cyst on my face, and nary a whisker has sprouted since. But, rather than go through all that again, I'll take the razor—for life.

Coming back to bragging, it has its points. For that matter, I'm somewhat inclined that way myself. On numerous occasions, f'instance, the Old Man would slyly assign me to some job that, by and large, had the possibilities of the celluloid dog chasing the asbestos cat through h—l. And I'd say "okay" and, having made my boast, there was nothing to do but make good. It may be more modest to say "I'll try," but when you say "I will" you either do the job or get off the stool.

Andy

THE *Fundamentals* OF TOOL ENGINEERING

The Elements of Gearing

No. 4 of a Series

HAVING previously discussed the rotary cutting of spur gears, we will now take up the rotary cutting of bevels. In this connection, we wish to point out that, with the exception of hobbing (a form of rotary cutting employed for spurs and worm wheels), this method is on the way out. That is, for mass production. However, it is still widely used and is the only practical method by which gears may be cut with ordinary tool room or machine shop equipment—as, for example, with milling machines and dividing heads. Rotary cutting is, therefore, essential to the "know-how" of gear manufacture.

In bevel gears, all lines—pitch, face and root angles; teeth, spaces and center lines of bores—converge toward a common center. See Fig. 1. While ordinarily operated at 90°, bevels may be run at practically any angle from near in-line to parallel—i.e., from acute to obtuse angles. When pinions run at obtuse angles, the gears may be crown or internal bevel; in any event, all lines converge. That is, with the exception of spiral bevels and hypoids, which operate on offset centers.

Fig. 1 is purely illustrative since the angles shown—30, 60 and 120 degrees—do not readily lend themselves to any even ratio of teeth. About the nearest, would be 26 teeth for the gear and 15 for the pinion, in which case the pitch cone angles would be 60° 1′ for the gear and 29° 59′ for the pinion. If, however, we assume the gears illustrated to be 6 diametral pitch and 36 and 18 teeth, respectively, for the gear and pinion, then, the gear would be 6″ pitch diameter and the pinion 3″. These diameters are arrived at as follows: $D' = N/P$, in which D' = pitch diameter, N the number of teeth and P the diametral pitch.

To lay out these gears, we will proceed along simple lines and, so that lay readers can follow the method, without involved mathematics. First, draw two intersecting center lines, one horizontal, one vertical. 3″ to the right of the intersection (to follow Fig. 1) draw a vertical line. Next, draw a horizontal line 1½″ below the horizontal center line. These lines represent the pitch radii of the gear and pinion. From the center lines, space off the pinion and gear pitch diameters—i.e., 3″ and 6″ respectively. From the ends of these diameters, draw converging lines to the center. This establishes the pitch cone angle, which can now be calculated from the known sides—i.e., the pinion radius divided by the gear radius = tan of pitch cone angle = $\frac{3}{6}$ = .500. Pitch cone angles are therefore 26° 34′ for the pinion and 63° 26′ for the gear, very nearly. The included angles would be 53° 8′ and 126° 52′, respectively.

Next, through the points of intersection of the pitch diameters, draw lines at right angles to the pitch cone radii —or all 26° 34′ from the vertical. This establishes the edge or heel angles of the teeth. Working outward on these lines, spot off the addendum which, for 6 pitch, is .1666″. This establishes the O.D. (D). Next, from the O.D., drop down the full tooth depth (D″ + f) which, for 6 pitch, is .3595″. We now have the bottom diameter D‴. From the outside and bottom diameters, draw converging lines to the center, when we have the face and bottom angles.

Next, establish the width of face—or length of tooth—which, to all practical purposes, can be 1¼″. (The maximum recommended is the circular pitch × 2.5.) Now, lay off 1¼″ on the pitch cone radius and draw a line perpendicular to it and ending just below the bottom or cutting angle. Next, determine the hub lengths which, for the gears described, can be 2″ for the gear and 2½″ for the pinion. The hole in the gear can be 1½″, and that of the pinion 1″, with the outside diameters 3″ and 2″, respectively. These proportions leave ample stock for keyways and screws, not shown in Fig. 1.

About the only thing left, now, is to establish the face and bottom angles, shown respectively as c and d in Fig. 1, so that we can turn a blank and, later, cut the teeth. First, in this order, we establish the pitch cone radius, designated as A in Fig. 1. We have two known sides: B in the drawing, which is one-half the pinion pitch diameter or 1½″, and,

FIG. 1

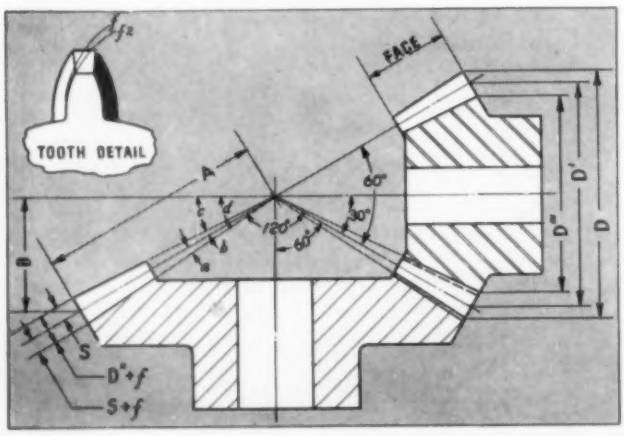
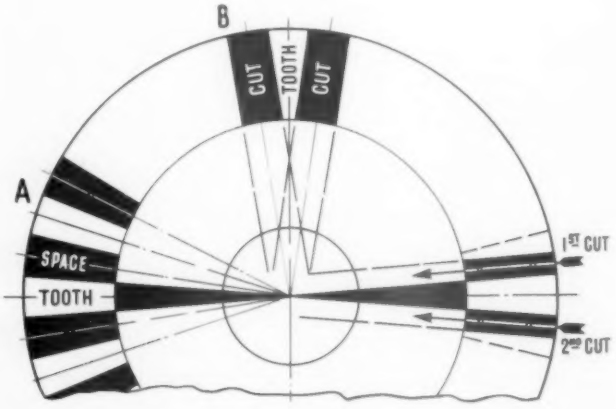


FIG. 2



one-half the pitch diameter of the gear—or 3"—which we will designate as C. Then, A is arrived at by simple calculation as: $A = \sqrt{B^2 + C^2} = 3.3541"$.

Now, taking the face angle, we have two known sides, as "s" (.1666") and A (3.3541"). Then, s/A = tan b = .1666"/3.3541" = .04969; b = 2° 51′ very nearly. Subtracting this from 26° 34′ we have 23° 43′ for the face angle "c."

To arrive at the cutting angle, we have the aforesaid known side A and depth of the tooth below the pitch line: (s + f)/A = tan a = .1928"/3.3541" = .05777". The resulting angle equals 3° 18′ very nearly. Add this to 26° 34′ and we have 29° 52′ for the cutting angle "d." That is, for the gear.

To get the face and cutting angles of the pinion, we proceed as above but, instead of subtracting 2° 51′ from the pitch cone angle, we *add*. Therefore, the face angle of the pinion would be 29° 25′. And, to obtain the cutting angle, we *subtract* 3° 18′, when we get 23° 16′. If, now, we subtract the face angle of the pinion (29° 25′) from the cutting angle of the gear (29° 52′) we will find that the difference (27′) will closely coincide with 1/10 of the tooth thickness at the pitch line, viz: 3.3541 × tan 27′ (or, tan 13′ 30" × 2) = .0263". The nominal clearance is .0262".

Apparently, then, the layout and calculations are correct, and while the explanation may appear more involved than the doing, the whole is illustrative and may be applied to the layout and calculation of any mating pair or train of straight tooth bevel gears. It's all comparatively simple.

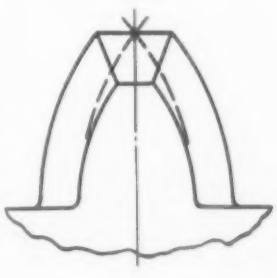
Figuratively speaking, we now have the gears designed and, from the drawing, can proceed to turn the blanks. We will first make the gear and, assuming that we do not have a bevel gear cutting machine, we will cut the teeth in a miller. First, we color the edge with prussian blue and, with a scratch gage* mark off the full tooth depth (D + f) to .3595". We then mount it on an arbor in a dividing head, which is set at the proper cutting angle—or 29° 52′—from the vertical. (For the pinion, the angle would be 66° 44′.) Now, however, we run into the complications inherent in rotary cutting.

As stated above, all lines of bevel gears converge. By referring to Fig. 2, this convergence—of tooth and space centers and sides of teeth—is clearly shown at A. If, however, we were to run a spur gear cutter through on the center line, we would have a comparatively straight cut (or space) and a tooth whose sides would diverge from the center. We, therefore, use a *bevel gear cutter* which is as thin, across the pitch line, as the narrowest tooth one would expect to cut. However, the range—as from 12 teeth through to a rack—corresponds with the range of spur gear cutters, and for the gear and pinion under discussion we would use a No. 2 and No. 6 cutter, respectively.

To insure the correct convergence, we offset the cutter from center, and first cut one side of all the teeth. That done, we set the cutter over a similar amount to the opposite side, and take a second cut, as shown at the right of Fig. 2. If the offset has been correctly calculated, we will have converging teeth and spaces as at A. But, we will not have a correct tooth profile except at the extreme edge.

The reason is that, as the cutter feeds toward the center, on the cutting angle, the pitch line progressively rises. Because of this, the small end will have the same curve as the larger, as shown by lines f and f^2 in the detail, Fig. 1, and by the dash lines, Fig. 3. In rotary cutting, there is nothing we can do about this, so, when the gears are cut, we run them together with prussian blue and file down the flanks until we get the uniform, converging flanks indicated by the solid line, Fig. 2.

FIG. 3



In this connection, about the only practical method by which bevel gears may be cut with *all lines converging* is by generating, as with the Gleason system of shaping. Here, the direction of each successive cut is toward the common center of convergence, with the gear rolling during the cut. However, we need not go into this method here, since it is comprehensively treated, along with other modern techniques, in the *Symposium on Gears* which is a feature of this issue, THE TOOL ENGINEER.

Now, come back to the offset of the cutters. There are several methods of calculation and, in commercial cutting, calculation is simplified by factors or tabulated constants. Since, however, it is better to know the *fundamentals*—which can't be mislaid—it may be as well to show a simple method applicable to most conditions.

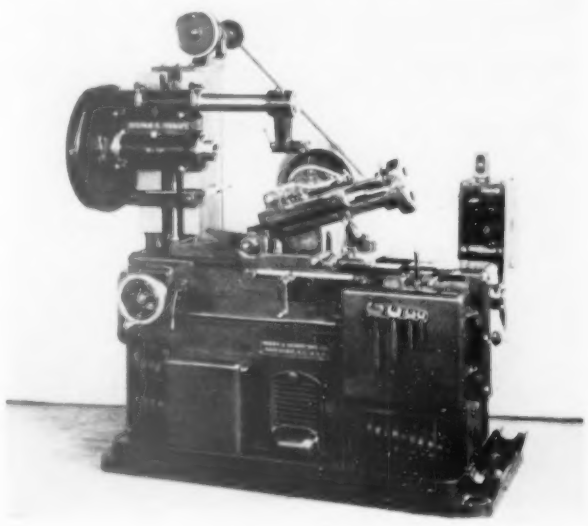
Working with the pair described above, we have a gear 6 pitch, 6" pitch diameter, 36 teeth. The thickness of the tooth, large end, is .2618", and the length 1¼". Since the pitch cone radius is known—3.3541"—it is quite easy to figure the taper per inch, which is .2618"/3.3541" = .07805". Therefore, the thickness of the tooth on the pitch line, small end, would be .2618" minus .07805" × 1.25" = .16434".

Now, since all lines converge, it follows that both flanks of the tooth would also converge at the common focal point. Therefore, if the cutter is set dead central with the flank of the tooth at the pitch line, it can then be offset ½ its thickness at the point or thinnest section. This point is chosen in preference to the pitch line, which rises in cutting, whereas the bottom of the cut, at the cutting angle, will remain fairly constant.

To check the offset, however, and to avoid spoilage, one takes two shallow cuts, one on each side, when the proportions of the tooth may be gaged with a vernier gear tooth caliper.† Should the proportions be correct, one can then take the full cut, one side, then, offsetting to the opposite side, complete the cutting. If, however, the tentative cut is off, one may easily calculate the correction from the trial reading.

Next, in this Series, we will take up the calculations of Gears.

FIG. 4. Automatic Bevel Gear Cutting Machine. Photo by courtesy of Brown & Sharpe Mfg. Co., Providence, R. I.



*†For micrometer gear tooth depth gage and vernier gear tooth caliper, see illustrations in *The Evolution of the Gear*, starting on page 18, this issue.

GADGETS

Ingenious Devices and Ideas to Help the Tool Engineer in His Daily Work

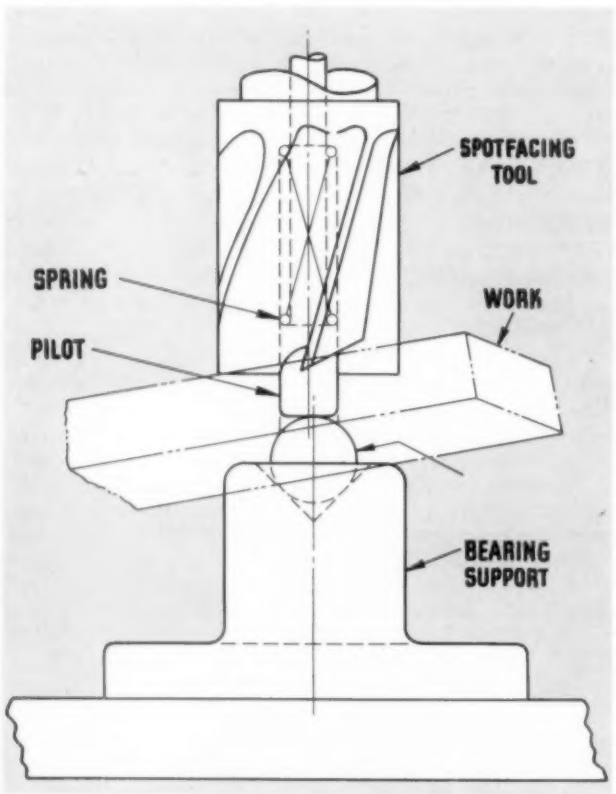
Compound Angle Spotfacing Fixture

MOST PRODUCTION JOBS requiring special fixtures for spot facing at compound angles in relation to the drilled hole can be eliminated when using a spring loaded pilot set into the spotfacing tool and using a ball bearing as a support resting on the drill press table.

The pilot is inserted into the hole that has previously been drilled at a compound angle to the base which, in turn lines up the work at the proper plane. As the spotfacer descends, the pilot slides into the spotfacing tool.

This idea can be applied successfully on aluminum parts up to approximately $\frac{3}{4}$" dia. spotface.

A. N. Segal, Montreal, P.Q.



A Case for Good T-Slot Bolts

To the Editor:

We house our machinery in modern buildings and take care to keep them clean, but, we abuse our machinery beyond reason by not providing T-slot bolts.

Most metal working machinery is provided with T-slots in their tables for fastening work. In modern production, these T-slots are completely finished by milling or planing; consequently, every surface is finished smooth and square. But, when the machines are put in operation, any kind of hodgepodge bolt is used for fastening work. It does not take long use of a machine to ruin the T-slots with such bolts, and after that has happened, a most essential part of the machine is ruined.

The cost of proper T-bolts is very small, and I hope that my observation expressed here will reach the men in authority to avoid this deliberate ruin of American machinery.

Julius Michelson,
Hartford Chapter, A.S.T.E.

Pipe Bending Simplified

WHEN BENDING TUBES on standard tube bending machines it is often a question how to handle reverse bends in the form of an "S," or bends which cannot be properly gripped by a holding block due to the proximity of the previous bend.

In the past, expensive dies were developed for press operation which necessitated laborious filling of the tubes with "Cerrobend" before forming and emptying after forming. Some companies went into tricky and clumsy wiping fixtures which were either too difficult to handle for mass production or had a high percentage of rejects. Others heated the tubes and pounded them into shape, producing no two alike.

However, by the use of a simple set-up and bend block constructed as illustrated, tubes of all sizes, from aluminum to chromemoly steel (SAE 4130), have been bent quickly, cheaply and most important of all, uniformly.

In bending tubes the procedure is as follows:

1. The first bend is made on any standard tube bending block.

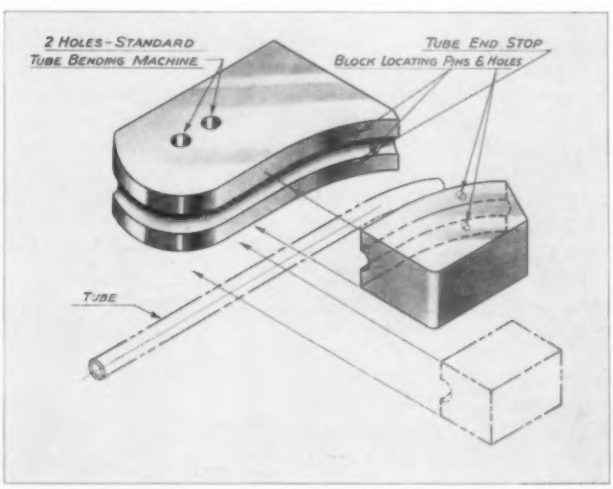
2. A block is then made to incorporate the first bend and to bring the part to be bent into the plane of the mandrel. Care should be exercised in that the holding block be made slightly undersized to provide a firm grip on the tube.

3. Finish bend.

The above operations may be separated as often as required to complete the job, merely by incorporating the previous bend or bends into the block. The bend blocks can be made from laminated phenolic or, for high production runs, from steel. The locating pins should be of hardened steel press fitted into the block.

NOTE: In some cases trouble with spring-back may be encountered—if so undercut the block to compensate for it.

N. P. Abramowitz,
Phila. Chapter, A.S.T.E.



North East West South in Industry

Recent promotions at **STANDARD GAGE COMPANY, INC.**, Poughkeepsie, N. Y., include **Nils Holve** (top), made assistant to Erik Aldeborgh, president; **Alfred H. Emery**, stepped up to chief engineer, and **Noel de Cordova,*** appointed sales manager.

A native of Sweden, Mr. Holve held responsible executive positions with the DeLaval Separator Co., Stockholm and Poughkeepsie, General Motors Export and Electrolux before joining Standard Gage in '36.

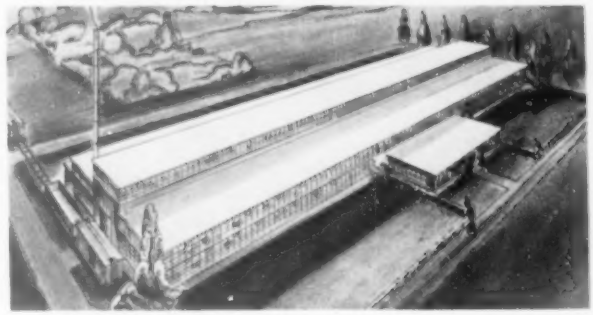
Joining Standard Gage in 1925, when the company was in its infancy, Mr. Emery is credited with many important developments during his 20 years of service. At present, he is preparing a number of new instruments, soon to be announced, for production. Included in his new duties, as chief engineer, will be full responsibility for research and development.

*An account of Mr. Cordova, who is an ASTE member, was published in the News Section, December issue.

John D. Gordon has been appointed general manager, and **Carl Halpin** manufacturing work manager of **PROGRESSIVE WELDER COMPANY**, Detroit. Mr. Gordon will be in complete charge of all operations, including engineering. Mr. Halpin leaves an extensive consulting practice to take over the production management of Progressive's expanded line of resistance welding equipment.

Frank Davis, formerly Tool Supervisor at the Allison plant in Indianapolis, has joined **SAMUEL HARRIS and COMPANY,** Chicago. He will be in charge of Harris' new Carboloy Cutting Tool Division.

Wm. F. Reiff, Jr., Harold L. Gardner and **Paul E. Clasen** have founded the **GARCO MACHINERY CO.** in Cleveland. Wm. F. Reiff was counsel on tooling problems for the War Department and is a past Chairman of Cleveland Chapter, A.S.T.E. Harold L. Gardner has been active in sales engineering over a period of 17 years, while Paul E. Clasen specializes in advising on large machine tools and is widely experienced in the screw machine parts field. Their company will represent, exclusively, the complete line of Gerotor air and hydraulic valves, cylinders and pumps, manufactured by Gerotor May Corp'n, Logansport, Ind.



HYDRO-POWER, INC., manufacturers of hydraulic pumps, valves and controls, have a new plant under construction at Springfield, Ohio.

Hendley Blackman has resigned as manager of the **WESTINGHOUSE ELECTRIC CORPORATION** Editorial Service to become Electrical Editor of *Product Engineering*, a McGraw-Hill publication.

Arthur H. Brown, who has been named Manager of Sales, Pittsburgh and vicinity, for **LUKENS STEEL COMPANY** and Subsidiaries, By-Products Steel Corporation and Lukenweld, Inc., Coatesville, Pa. Associated with Lukens since 1930, as a member of the Direct Sales staff, he was previously with the New York sales office and the Steel Plate and Flanging Sales offices in Coatesville.

George H. Fobian, formerly vice-president and director, has been elected president of the **OILGEAR COMPANY**, Milwaukee, to succeed the late Mr. Harry M. Swigart.

Lynn Matthias, Director of Research, **ALLEN-BRADLEY COMPANY**, Milwaukee, has been selected to visit motor control plants in Germany and to report to the industry on foreign controller developments and practices. He will be under authority of the U. S. Army Intelligence Service, Technical Division.

AMERICAN CHAIN & CABLE COMPANY, INC., Bridgeport, Connecticut, has acquired the business of the Certified Gauge and Instrument Corp., of Long Island, N. Y. Manufacture will continue under the name Helicoid Gage Division, American Chain & Cable Company, Inc.

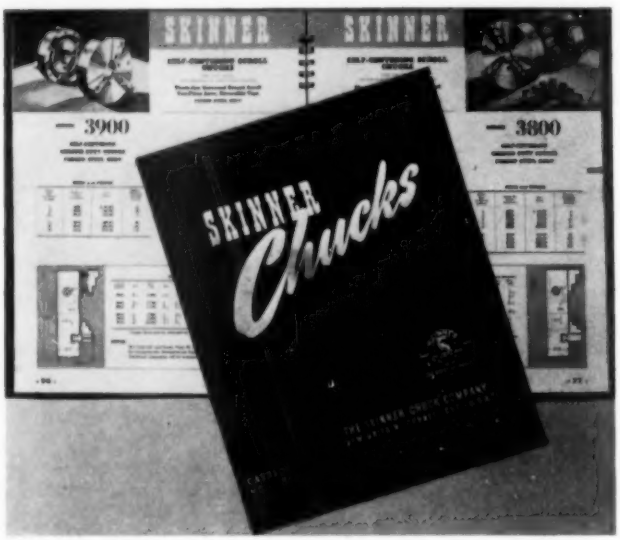
Harold J. Thompson has been appointed as district manager of the **RELIANCE ELECTRIC & ENGINEERING COMPANY,** in Gary, Indiana. He will serve the industries of the Calumet and Northern Indiana districts.

The **NATIONAL METAL EXPOSITION** will be held in the Public Auditorium, Cleveland, February 4-8, 1946. Complete details may be had from W. H. Eisenman, secretary of A.S.M., 7301 Euclid Ave., Cleveland 3, and from Frank Sisco, Ass't Sec'y Amer. Inst. of Mining and Metallurgical Engrs., 29 W. 39th St., New York, N. Y.

BULLETINS AND TRADE LITERATURE

Items briefed herein have been carefully selected for their interest and application. Unless otherwise stated, all are available, free, from the stated sources.

THE SKINNER CHUCK CO., New Britain, Conn., has issued an attractive catalog—No. 58—describing and illustrating chucks, milling machine vises, power chucks and other Skinner accessories.



THE NORTON CO., Worcester, Mass., has released a folder describing the industrial applications of *Norbide*, the hardest artificial material known.

DIE SUPPLY CO., 5345 St. Clair Ave., Cleveland 14, Ohio, has published a revised *Die-Co. Accessories Catalog—No. 4*—illustrating a complete line of accessories including die springs, socket and machine screws, "hardsteel" drills, toggle clamps and jig and fixture parts. Charts in the catalog list sizes and data pertaining to load and deflection of springs, applications and other useful information.

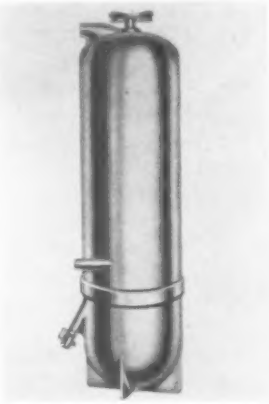
FEDERAL TOOL AND MFG. CO., 3212 Washington Ave., Minneapolis 12, Minn., has issued a circular describing special dies for small quantity stampings.

ISLAND EQUIPMENT CORP'N, 101 Park Ave., New York 17, has issued a comprehensive bulletin on their new *Power-Flex* conveyors.

MICHIGAN TOOL CO., 7171 E. McNichols Rd., Detroit 12, has published a 4-page bulletin describing improved models of *Sinc-Line Involute Checkers* for both spur and helical gears.

THE STANDARD ELECTRICAL TOOL CO., 2499 River Road, Cincinnati 4, Ohio, has issued a 4-page folder describing variable speed buffing and polishing machines.

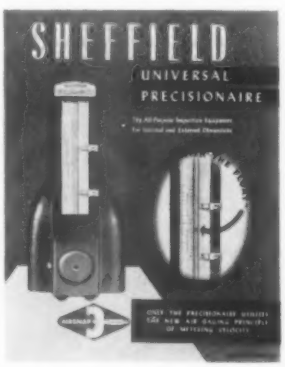
CUNO ENGINEERING CORP'N, Meriden, Conn., has available a bulletin on its new *Coolant-Klean* filter designed to remove abrasive and metallic particles from grinder coolant. The new filter can be applied to any type of grinder and is also adaptable to any machine tool using a coolant or cutting oil. The replacement of the bag-type filter element is accomplished in less than 5 minutes, and the installation of the unit in about 15 minutes. No extra pumps, electrical work or plumbing is required.



HAGAN CORP'N, Hagan Bldg., Pittsburgh, announced a bulletin on the *Thrusttorq*, air-operated measuring device for engine hp.

JOHN S. BARNES CORP'N, Rockford, Illinois, has issued Bulletin No. 3024U, describing the uses and advantages of Barnes L-type *self-contained hydraulic units.*

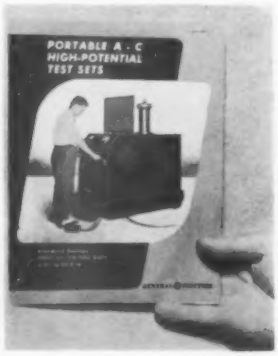
THE SHEFFIELD CORP'N, Dayton 1, Ohio, has published an attractive new catalog which illustrates and describes the universal *Precisionaire* instrument. This instrument, which measures through air velocity instead of pressure, eliminates the human element of error and requires no skilled operator. The amplification range is from 1000 to 1, to 25,000 to 1. Accuracy is instantaneous, without any time lag.



MILL AND FACTORY, 205 E. 42nd St., New York, has published a profusely illustrated *Maintenance Manual*—No. 1—which gives rules for proper care of chains and electric hoists.

N. RANSOHOFF, INC., Cincinnati 16, Ohio, has published profusely illustrated, informative catalogs describing their line of metal cleaning equipment.

GENERAL ELECTRIC CO., Schenectady, N. Y., has announced a new, 24-page bulletin, containing data and descriptive information on the complete line of portable a-c test sets from 2000 to 150,000 volts. This publication also contains listings and description of sphere gaps and current-limiting resistance assemblies for use with a-c testing sets.



TOOLS OF TODAY

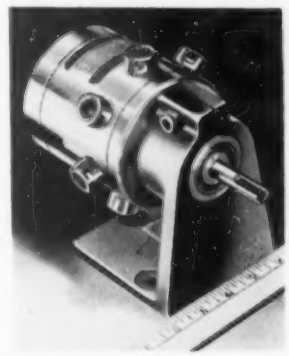
New Planetary Miller

A NEW PLANETARY MILLING MACHINE by the *Plan-O-Mill Corporation*, 1511 E. Eight Mile Rd., Hazel Park, Mich., is designed especially for high volume, low-cost thread and form milling. Called Plan-O-Mill No. One, it differs from previous planetary milling machines in size—less than 9 ft. in all—and unusual ease of operation. Completely anti-friction, it is said to provide thread-milling accuracy with tapping speed, with an advance in accuracy, trouble-free operation and simplicity of set-up, and, with added emphasis on economy. It incorporates earlier Plan-O-Mill features, as push-button operation, coordinated feeds and speeds, and Thy-mo-trol electronic feed control—engineered by General Electric and pioneered on Plan-O-Mill—for split-thousandth control of feed-in and feed-around.

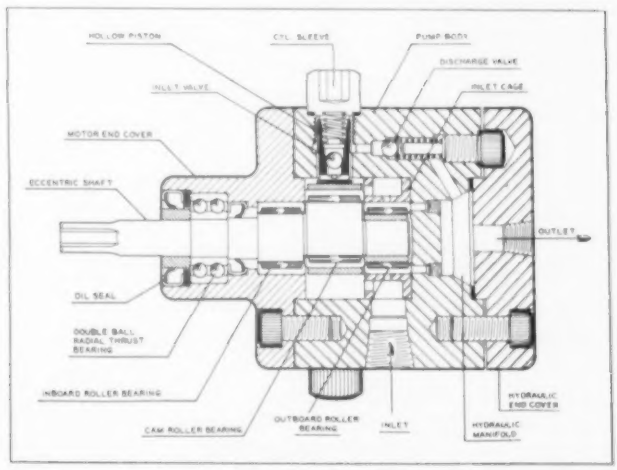
With this machine, a complete part can be milled in a single operation requiring as little as 8 seconds, and, since the part itself does not move—(the revolving cutter being fed around the work)—large and cumbersome parts may be handled with a high degree of ease and speed. The machine, which is operated by means of an electronic control panel (which may be mounted on the floor, wall or ceiling), has facilities for either external or internal threading, and threads and mills parts up to 2" I.D. or O.D., or larger with offset head. An illustrated catalog is available on request.

New Hydraulic Pump

THE SECO RADIAL HYDRAULIC PUMP, built by *Simplex Engineering Co.*, Zanesville, Ohio, utilizes the principle of inherent sealing by the fluid pressure. This is accomplished by the use of the hollow piston; the higher the pressure, the tighter the seal between the moving piston, cylinder sleeve and pump body. The pumps are capable of generating oil pressures as high as 10,000 P.S.I., thereby permitting the use of small units. The displacement per revolution is constant; they can, however, be used for variable delivery by driving from the prime mover through a variable speed transmission.

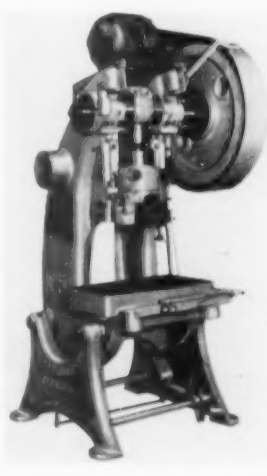


Mounted unit at right; cutaway view below.



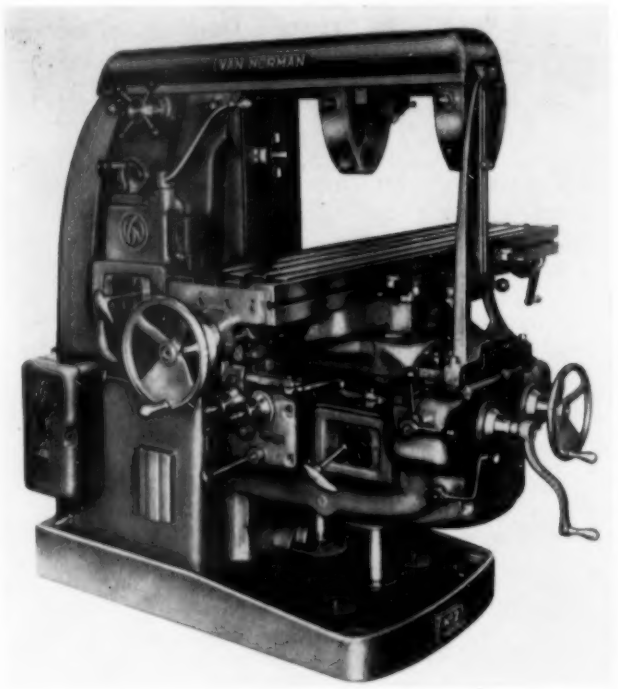
Inclinable Press

VARYING FROM 6 to 8 tons capacity, a line of INCLINABLE PRESSES, manufactured by the *Walsh Press & Die Company*, 4743 W. Kinzie St., Chicago, embodies all of the conventional features of inclinable presses as well as several new developments. These include ground crank shafts, hand scraped bearings, ready inclinability and a simple two-button safety device for protection of operators. Descriptive literature available on request.



Van Norman Heavy Duty Miller

THE NEW No. 2 HEAVY MILLER, plain and universal, by *Van Norman Co.*, Springfield, Mass., has the following specifications: Table 58 x 13 inches, drive motor 7½ H.P., longitudinal table range 28", cross 10" and vertical 17". 18 speeds are available from 30 to 1500 R.P.M., and 18 feeds, from $^3/_8$" to 32". The universal saddle permits the table to be swiveled 45° both ways.



A feature of this machine is a heavy, large diameter flywheel mounted on the exceptionally large cutter spindle inside the column. This assures uniform application of power to the tool and reduces cutter vibrations to a minimum. The single lever speed and feed selectors provide quick and easy selection of 18 speeds and 18 feeds. Hand feeds are also providd in both front and rear of the miller.

Automatic lubrication to all moving parts, safety devices in the knee to eliminate strain on any unit of the mechanism, hardened alloy steel gears and shafts and anti-friction bearings contribute to speed, accuracy, surface finish and safety of the new HEAVY DUTY MILLER. Descriptive literature will be mailed upon request.

New P-M Surface Grinder

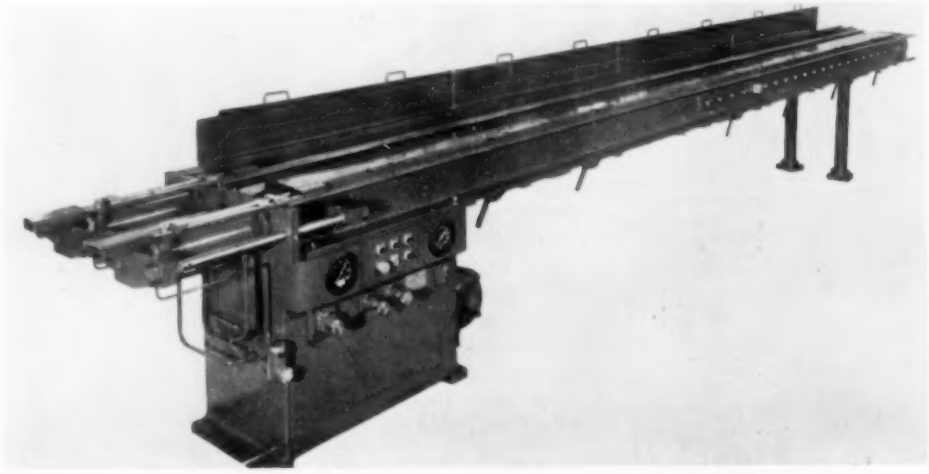
A NEW SURFACE GRINDER by *Parker Majestic, Inc.*, 147 Jos. Campau, Detroit 7, Mich., embodies new features claimed to be found in no other grinder. These include a saddle locking mechanism and a multiple-speed unit giving seven spindle speeds, ranging from 2160 to 6000 R.P.M. This speed range permits the use of grinding wheels from 2 to 10 inches in diameter.

On the whole, the machine incorporates the features of design and construction considered essential in a high grade grinder. Work table ways and working surfaces are hand scraped for precision bearing and good lubrication; and all working surfaces subject to abrasion dust have been properly covered. The machine also incorporates vernier cross feed.

The capacity: Longitudinal travel, 18 inches, traverse, 6 inches, and vertical 13 inches to spindle center line.

Tensile Strength Tester

A NEW TENSILE STRENGTH TESTER, for testing the tensile strength or the modulus of elasticity of bar stock, wires, cables and chains, is a recent development of the *John S. Barnes Corp'n*, 3015 Water St., Rockford, Ill. The machine is designed to enable inexperienced operators to make tests that are quick, safe and yet highly accurate.



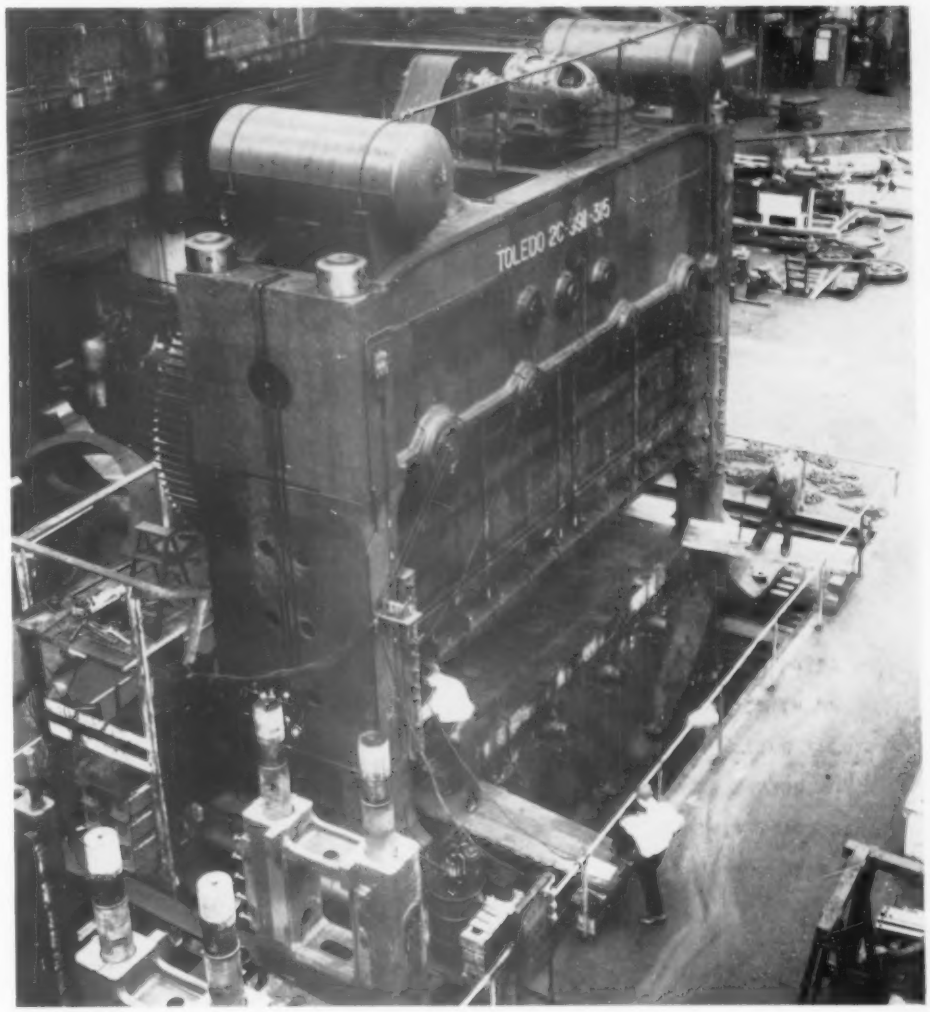
Two 4" bore x 8" stroke low friction cylinders provide initial test loads up to 1500 pounds; however, final test loads may be as great as 15 tons. Illustration shows the front safety cover down, in testing position, while the rear safety cover is open in loading position.

New Chassis Frame Press

A GIANT CHASSIS FRAME PRESS, built by *E. W. Bliss Co.*, Brooklyn, N. Y., is capable of producing two chassis frames every ten seconds, if material handling can be accomplished into and out of the machine. Capacity is 2500 tons pressure at bottom of stroke. The weight is about 750 tons. It is a two-crank, straight side, single-action press provided with a multiple disc air-operated friction clutch with electric push button control and air-operated flywheel brake.

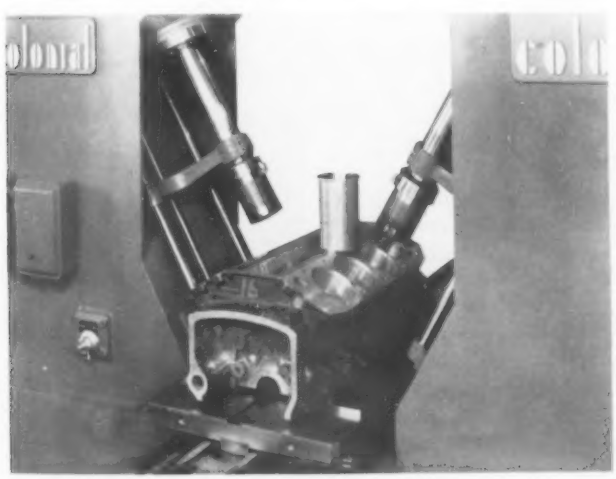
The bed area is 80", front to back, by 315" left to right. It will accommodate two sets of identical dies to make rails for trucks, tractors or automobiles, box car ends and main beams for freight cars. The crown, 30 feet long and 7½ feet high, is a monobloc casting weighing 147,706 lbs. The slide, weighing 143,000 lbs., is also a one-piece casting, while the bed is a two-piece casting.

This machine was recently shipped to Russia and will be used in the rapidly growing Soviet automotive industry. Fifteen freight cars were necessary to move this huge machine.



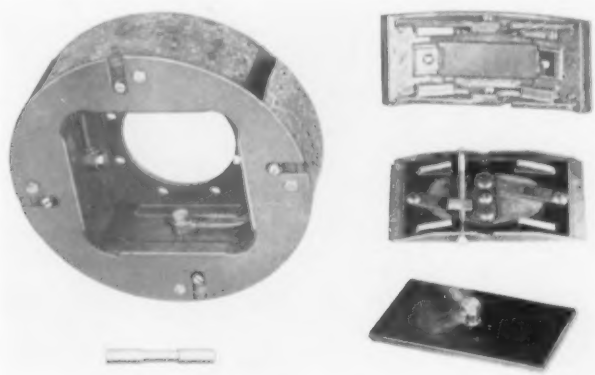
New Assembly Press

A NEW SPECIAL ASSEMBLY PRESS, by *Colonial Broach Co.*, Detroit, is used for assembling engine parts. The chilled steel sleeves are pressed, two at a time, into bores of preheated V-cylinder engine blocks. Since it is necessary to "set" the sleeves after cooling to prevent their tendency to "crawl" up out of the bores, this machine operates on a combination of hydraulic pressure and impact.



New Industrial Brake

AN INDUSTRIAL BRAKE, operating on ordinary factory airline and capable of exerting a high braking effort, without "seizing" or "grabbing," is announced by the *Linderman Devices*, Newburgh, N. Y. Simple in design, the brakes may be directly connected to machine shafts, or they may be attached by flexible couplings or by chain and sprocket drives. They operate in either direction. Above (left) is the complete brake; below, the torque bar for shoe; right (top to bottom), the two shoe parts and the multi-stage diaphragm.



New Hardinge Precision Lathe

A NEW **MODEL BENCH LATHE,** by *Hardinge Bros.*, Elmira, N. Y., incorporates many outstanding features. These include dovetail steel bed ways, a fully enclosed headstock and built-in electrical equipment that provides magnetic control. Time lag thermal overload relays prevent overload and provide low voltage protection.

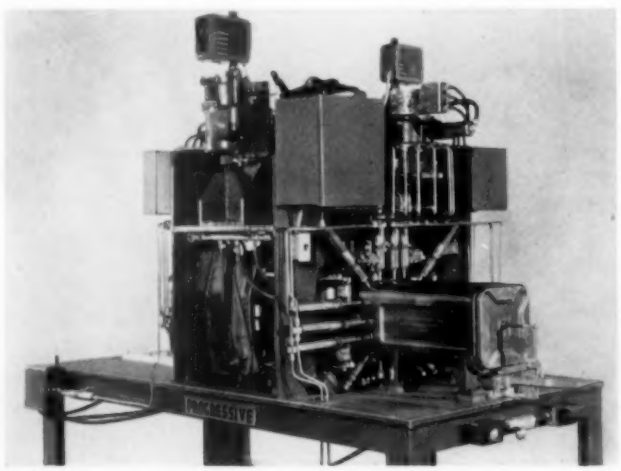
The spindle, running or pre-loaded ball bearings, is driven by a "center belt." A new compound slide rest is securely anchored by a patented, positive lock which provides rapid positioning. The tailstock spindle is provided with a ball thrust that has a constant, full bearing, regardless of its position in the tailstock body.

The machine incorporates all of the prewar Hardinge quality and finish, plus improvements and is shipped complete with motor and wiring.

Dual Hydromatic Spot Welder

WHILE DESIGNED for assembly of ammunition boxes, a **DUAL HYDROMATIC SPOT WELDER,** product of *Progressive Welder Company*, Detroit, is typical of many war developments which are destined to reduce production costs of consumer goods. Combining several operations in one, this dual welder (there is a duplicate welding station in back of the vertical panel) permits of a very high output in a minimum of floor space.

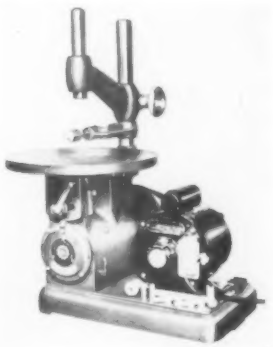
Economy of equipment is secured by using only a single transformer for both welding stations and using standardized parts for the various "guns." Simple air shuttling fixtures reduce loading time. These have interlocking controls so that one operator welds while the other one is loading.



Triple-Purpose Die Filers

DESIGNED FOR FILING, sawing and stoning, a line of **DIE FILERS,** by *Illinois Tool Works*, 2501 N. Keeler Ave., Chicago 39, embody balanced completely enclosed moving parts and forced feed lubrication. The tables can be tilted, permitting any desired clearance angle from 0° to 20°. Another feature of the Die Filers is that by removing the overarm and substituting a roller support, one may use hand files. A die room necessity, these machines are adaptable to a wide range of work.

Floor model Die Filer shown at left, with bench model below. The machines are alike except for the floor stand.



New Method Embossing Dies

EMBOSSING AND DEBOSSING DIES of consistently high mating accuracy are now being produced by *New Method Steel Stamps, Inc.*, 147 Jos. Campau, Detroit 7.

In the process of manufacture, which combines metal spraying and pantographic engraving, a brass pattern is first prepared for the male die. After being used as a template in the pantographic milling of the male die, white metal is sprayed onto the pattern to a depth of about $\frac{1}{8}$". This forms the female die pattern, and gives an exact reproduction of the male die. The result is an extremely accurate mating of male and female dies, and further assures that there will be no shear in the sheet metal embossed.

New Method of Roller Coating

A NEW METHOD OF ROLLER COATING, by the *Japan Company*, 5103 Lakeside Ave., Cleveland, permits the products to be finished *before* such operations as stamping or forming. Metal, wood and plastic products are finished in this way. All types of coating are applied with uniformity of thickness and color shades. The illustration shows a deep-drawn metal cup, roller coated with a vinyl plastic coating before forming.

GOOD READING

A Guide to Significant Books and Articles of Interest in the Trade Press

The January issue of MATERIALS & METHODS is a combination *Annual Engineering Review and Metal Show* number. The Engineering Review is divided into two sections: (1) materials and their application, (2) methods for processing materials. In the first division, the following subjects are treated: Steels and irons, non-ferrous metals, nonmetallic materials, fabricated materials and parts and coatings and finishes. The second section covers: Melting and casting; rolling, wire drawing, extrusion; forging and forming; powder metallurgy; machining and grinding; heat treating and heating; welding, joining and fastening; cleaning and finishing; testing and inspection; instrumentation and control. The Metal Show preview (the show will be held in Cleveland in February) presents detailed technical programs and a list of exhibitors.

CONSTRUCTION AND OPERATION OF NEW INJECTION CARBURETOR, by a staff writer, in December *Aviation*, reveals for the first time the engineering details, together with well illustrated operating technique, of the new Stromberg "PS" model small-plane injection carburetor.

MANUFACTURE OF FILE-HARD PRECISION GEARS, by W. G. Guthrie, in December *Metal Progress*, gives a comprehensive and exhaustive explanation of manufacturing and heat treatment processes resulting in tooth surface hardness C-60 to 61 Rockwell. The author's conclusion is, "no heat treating department could do a real precision job without careful and competent employees and supervisors."

THE FLASH WELDING OF STEEL, by J. C. Barrett, in December issue *Iron & Steel Engineer*, points out the improvements accomplished in flash welding. The author sets forth the principles of the process and illustrates their applications to modern production problems. The article is illustrated with many diagrams and actual photographs.

RADAR FUNDAMENTALS FOR ENGINEERS, a staff written article in December *Product Engineering*, is based on a report submitted to the Navy Dep't by the Westinghouse Research Laboratories. The fundamental principles of radar are presented with a view toward acquainting product designers with the basic concepts of the "sixth sense."

STRETCH-FORMING ALUMINUM ALLOYS AT ELEVATED TEMPERATURE, in December 6 *American Machinist*, is the last article of a series, started in Nov. 8th issue, by George Sachs, George Espey, and W. F. Brown of Case School of Applied Science. The authors presented the data of their experiments with annealed aluminum alloys. Some of the results of their research are:

1. Commercial soaps provide most dependable high-temperature lubrication.
2. The increased temperature apparently
   (a) reduced friction over the crown, allowing minimum strains to occur in this region, and
   (b) it caused the strains to increase rapidly near the crown.
3. Progressive forming of aluminum alloys is suggested for improving limits under high heat.

POWDER METAL MACHINE PARTS, THEIR DESIGN, CHARACTERISTICS AND DATA, in the same issue, by A. J. Langhammer, describes the characteristics of powder metals, the design of dies and parts produced, tolerances and control of hardness. This article is of particular interest to product engineers.

INDEXING HEADS AND DEVICES, Part II, by John E. Hyler, in November *Mill and Factory*, comprehensively describes various kinds of indexing heads and their many applications. The article is profusely illustrated and shows the adaptability of indexing principle, not only to milling but to grinding, drilling and broaching operations.

FLASH WELDING FILLS A NEED, by Gillard C. Close, in December *Modern Machine Shop*, is very much similar to Mr. Barrett's article. The author gives numerous illustrations of properly designed parts for flash welding.

Also, in the same issue, **DESIGNING AND USING MILLING CUTTERS AND FIXTURES,** part III, by C. W. Hinman, is a continuation of the *fundamentals of jig and fixture design*. The article is illustrated with drawings of up-to-date devices.

Help Increase Production use the

SWEDISH INTERNAL INDICATOR GAGE

It can be set to any required size direct from Johansson Gage blocks or master ring.

This light, easily handled instrument when used by machine operators, or on final inspection, serves to increase production, reduce scrap and assure a more uniform product. It is a reliable, precision indicator designed for rapid, convenient and accurate measurement of internal diameters. The scale range is: Plus or minus 0.001" graduated to 0.0001" and minus 0.020" graduated to 0.001".

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IF YOUR ASSEMBLY NEEDS THAT MANY WELDS

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Above, right: Head of a typical PROGRESSIVE Ultra-Speed on a machine designed to weld a series of double rows of 40 spots in a large panel assembly. (Automatic indexing to 1/1000 inch; high speed "approach" to welding position; automatic cycle.)

Above: Heart of PROGRESSIVE Ultra-Speeds is this control unit with many exclusive PROGRESSIVE features.

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Doors Panels Trays

STOVES

Panels Doors

With the Progressive Ultra-Speed you weld the spots automatically at almost unbelievable rates—welding speeds up to 900 spots per minute are possible.

The welding guns apply the pressure on the work all at the same time, thus clamping it firmly in proper position before welding. They remain in contact after welding, thus eliminating sparking at electrodes.

The Progressive Ultra-Speed is versatile and you can projection weld as well as spot on the same job, using the type of welding best suited to each location or metal thickness.

Electrodes can be arranged in circles, rows, curves, stepped, etc.

NOTE: PROGRESSIVE Ultra-Speed machines are custom designed and built to order for the specific job, using standardized sub-assemblies to reduce initial cost and increase salvage value. We will be glad to tell you about the many exclusive features of the PROGRESSIVE Ultra-Speed.

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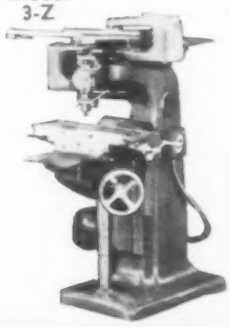
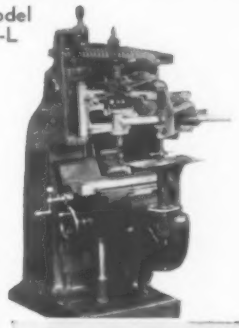
Model 3-Z



Model 3-L



Electric Control **DUPLICATORS**

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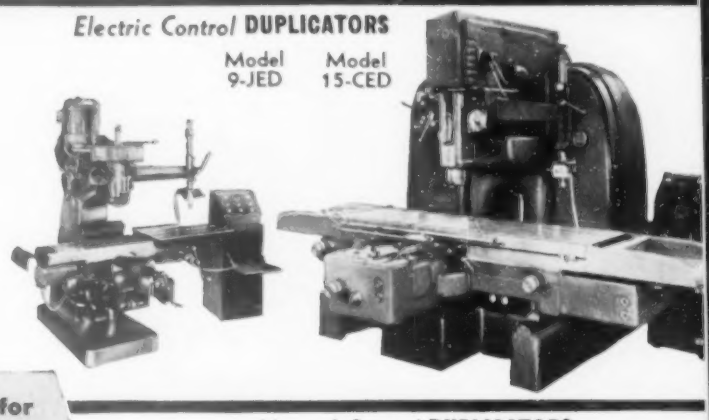
Model 15-CED



Super Speed **MILLING MACHINES**

Vertical and Universal Head

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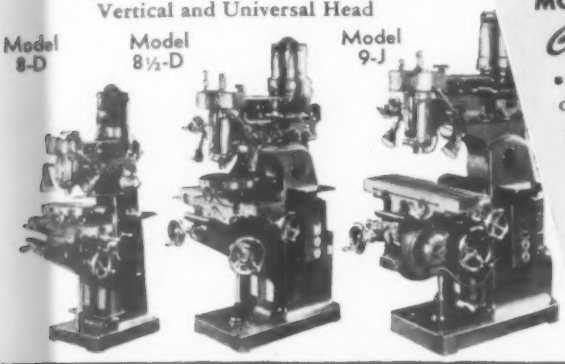
Model 8½-D

Model 9-J



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Model 8½D-D

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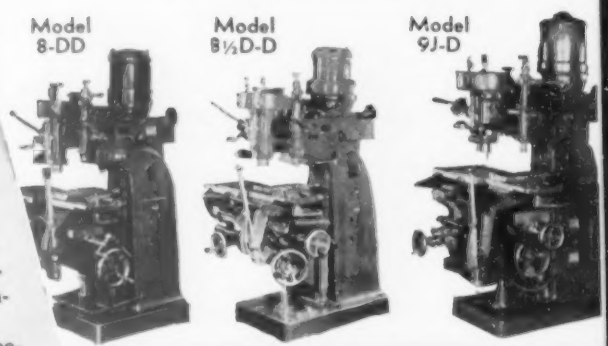
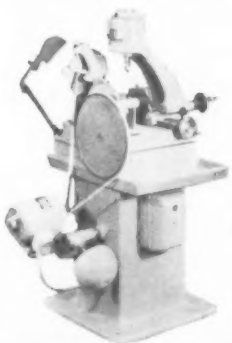


Cutter Grinders

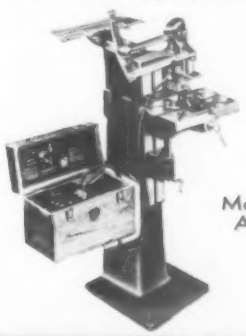
Model 375-2 with 717-1 Tool Head

Graduating Machines



Model 687-1

Electric Etching Equipment



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GEORGE GORTON MACHINE CO.

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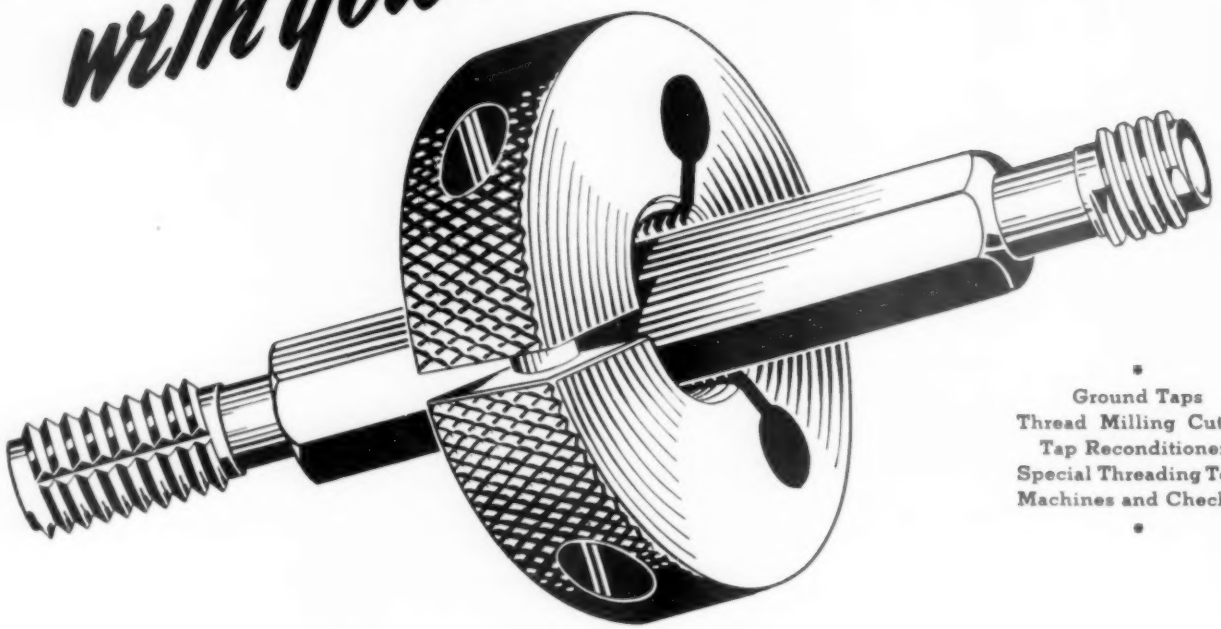
Don't get caught with your tolerances down



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History shows that industry never turns backward. This applies to tolerances, also. During World War II, thousandths and half thousandths shrank to one or two-tenths. Peace-time industry, in all likelihood, will continue to work to these—and even closer—tolerances.

You can obtain *from our stock*, for immediate delivery thread plug and ring gages, which will assure you that your threads are being held to today's close tolerances.

The Detroit Tap Representative in your area will be glad to advise you of the number of each size of gage in stock at any given time. Give him a call today.

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MAYBE it's a crankshaft or an armature . . . perhaps a fan or belt pulley. No matter. The important thing is this—if it isn't *balanced,* it isn't ready for service.

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put modern electronics to work to track down the elusive forces of unbalance. In ridding your product of these destructive forces, they eliminate the risk of overloaded bearings and premature wear due to vibration.

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BUSY TOOL ROOM CONCENTRATES ON *DUMORES!*

When Dumores are used on a lathe, they are usually mounted on the compound and fed to traverse the work. Here, however, the unit is mounted on the fixed support or column of the stationary grinder; the work, supported by an arbor, moves back and forth over the table of the machine. The Dumore Grinders, used on several such set-ups, are Model 12 units.

PRECISION, ADAPTABILITY AND VERSATILITY PROVIDE LOW COST TOOL MAINTENANCE

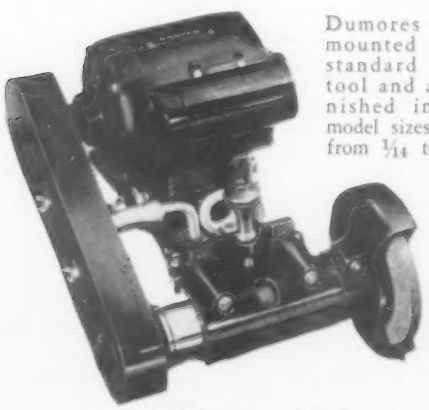
● At the Cullman Wheel Co., of Chicago, where sprockets and speed-reducing devices are produced in volume, many tools like hobs, cutters and reamers have to be sharpened carefully for close precision work — but also promptly to meet production schedules.

Though no definite tolerances are set, the resharpened tools must be as accurate as new. This means that tooth pitches have to be right and the diameter of various cutting edges, all around, uniform. No irregularities or chatter marks are tolerated.

Since work quantities are small and each job different, they found it possible to reduce set-up time and grinding cost by mounting Dumores on their machines. Each Dumore, with its perfectly balanced motor and vibrationless spindle, was capable of accuracy to ±.0001". And, in all cases, the spindle speed could be controlled for the best results. Naturally the Cullman Tool Room was pleased.

Because such performance is common with Dumores, though work applications vary greatly, we invite you to investigate these dependable, precision grinders. A complete, illustrated catalog will be gladly furnished upon request. The Dumore Company, Tool Division, Dept. TA-43, Racine, Wisconsin.

(Eastern Sales and Service Branch, 13 East 40th Street, New York 16, N. Y.)



Dumores can be mounted on any standard machine tool and are furnished in seven model sizes ranging from 1/14 to 1 h.p.

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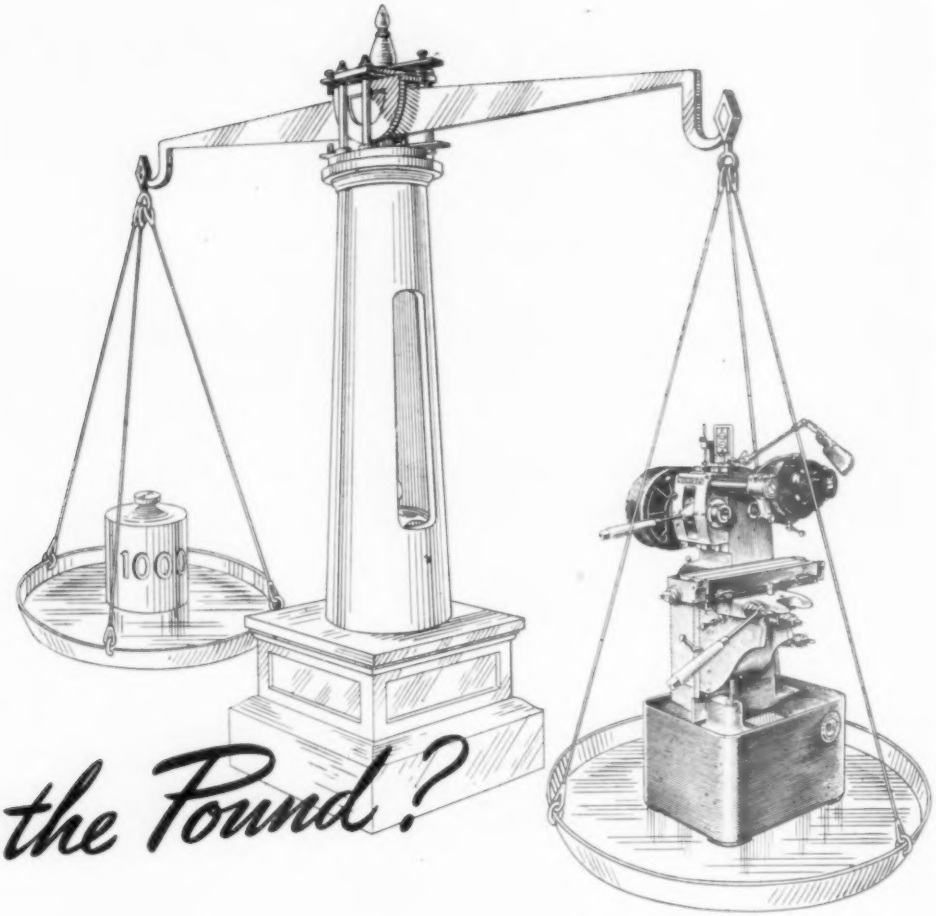
Sold by Authorized Industrial Distributors in All Principal Cities



...by the Pound?

The *price* of a machine tool *might be* measured by the pound . . . the *worth* of a machine *is always* measured by its economy, accuracy and production.

You will find that the Nichols Miller measures up to any yard-stick you may use for price and value.

The value of the Nichols Miller is increased by the fact that it "uses its head". The rise-and-fall spindle brings the cutter to the work, yet is so rigid that solid-spindle-accuracy gives chatter-free performance—in tolerances to "tenths". And, whether you use the Nichols for milling, boring, turning or grinding, you will be pleased with its economy and high production rate. A new illustrated catalog tells the whole story—write for your copy today.

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ON DURO METAL PRODUCTS CO.'S WRENCHES

Production costs in manufacturing open-end automotive wrenches hit bottom for the Duro Products Co. when simultaneous grinding of parallel surfaces is done on a Besly Double Spindle Grinder. The finish closely approaches perfection. Much less hand work is required in finishing and polishing—an important saving in labor costs . . . and quality of finish is improved. At each grind, approximately .020 is removed per side. Production averages 300 to 320 wrenches an hour.

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More Facts . . .

This model 218-20-inch Besly Double Spindle Grinder delivers accurately ground work for long periods with minimum maintenance. In this machine, the only parts to move in and away from the work are the spindle, bearings and the special quill or sleeve in which they are mounted. The sleeve moves freely on a grease-tight slide. Grit, dirt or water cannot enter to cause wear—and consequent major overhauls. This basic design feature also permits locking the Dresser-tie bar at the top in a fixed position—adding to machine rigidity and promoting greater accuracy of work.

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Write for it today on your business letterhead. It's a valuable reference on grinding wheels and abrasives. Besly Titan Steelbacs save "down time" . . . They step up production.

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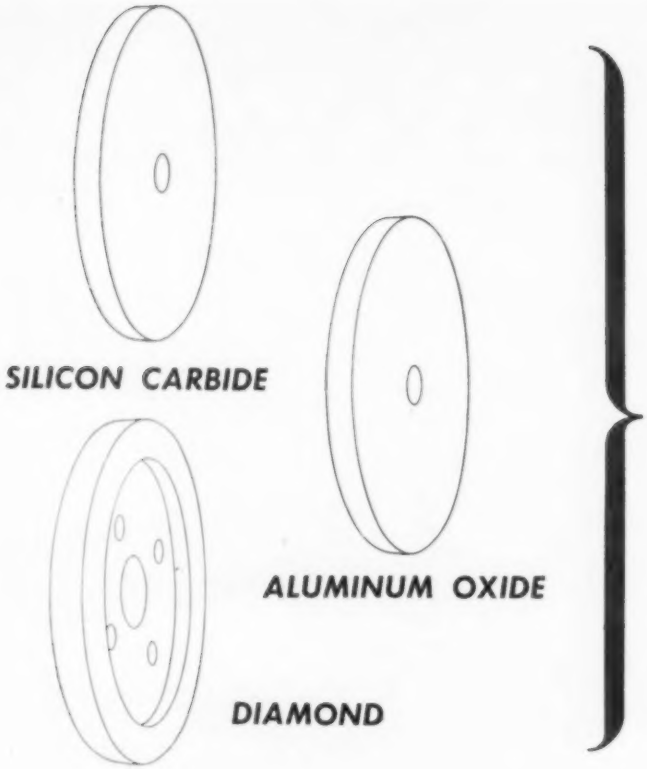
BESLY GRINDERS AND ACCESSORIES

CHAS. H. BESLY AND COMPANY, 118-124 N. Clinton St., Chicago 6, Ill., Factory: Beloit, Wis.



What doesn't SCIENCE know about abrasives?

When you look back on what Science has discovered in the past few years to give you better grinding wheels, there is a temptation to think there is not much left to learn. Science however, never stops its endless search into the mysteries of abrasives.

In our own laboratory, engineers and chemists are daily studying grinding problems and Abrasive Products by CARBORUNDUM. As a result, some of the hard and fast rules of a couple of years ago regarding the choice of abrasives for grinding wheels are now outmoded.

There are many special conditions which can affect the choice of abrasive wheels. It's a costly practice to assume that what works best on one job will turn out as well on another.

A different recommendation can mean faster feed, or a more desirable finish. The change can show up in lower production cost.

Give your CARBORUNDUM salesman or our distributor's representative a chance to help on your wheel selections. He has the advantage of being part of a well-knit organization of experts whose experience comes from handling thousands of new grinding problems each year. Supporting each recommendation is the knowledge of skillfully trained engineers and laboratory technicians.

You can save time and trouble by asking a CARBORUNDUM representative's advice on grinding wheels. The Carborundum Company, Niagara Falls, N. Y.

A good rule for good grinding . . .

CALL IN CARBORUNDUM

TRADE MARK

ABRASIVE WHEELS
Silicon Carbide
Aluminum Oxide
Diamond

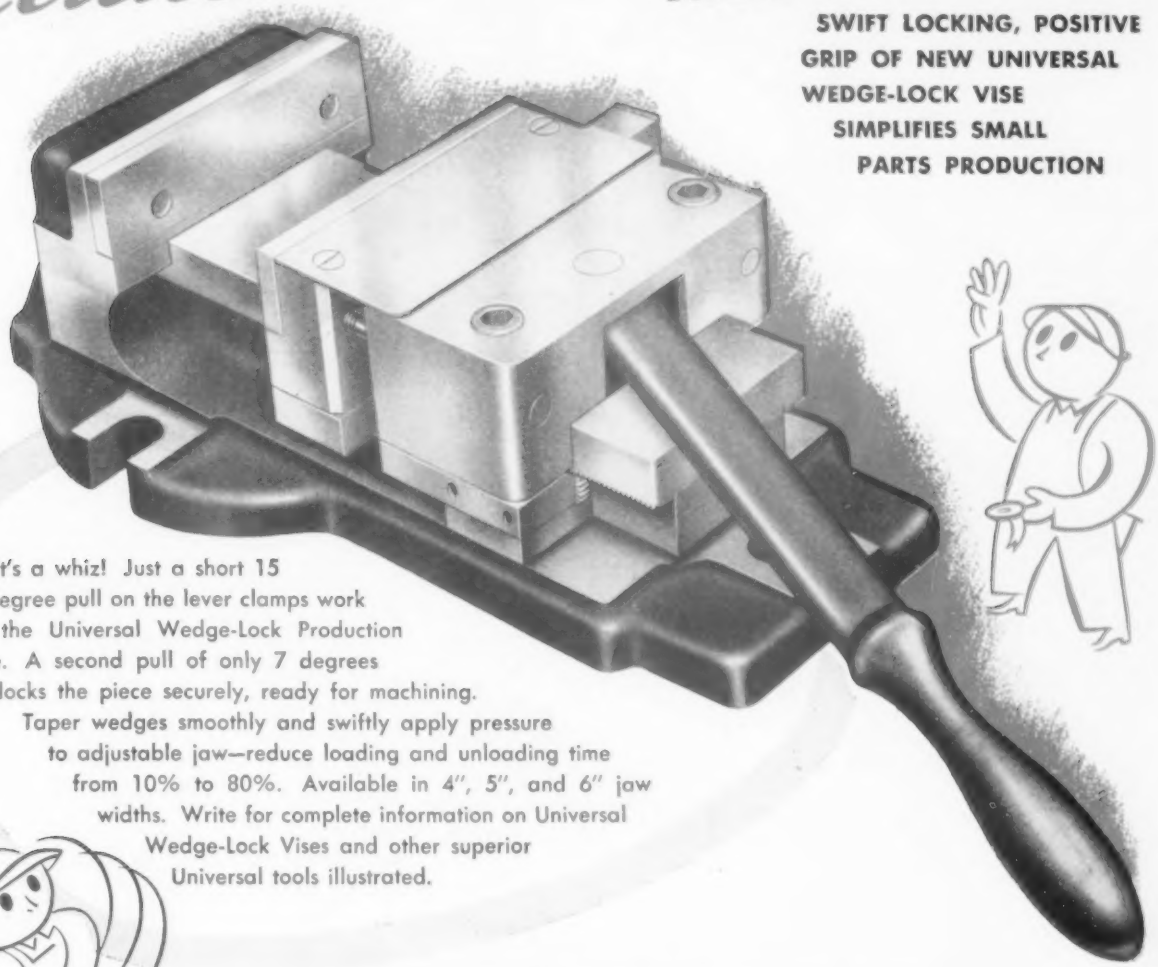
COATED AND BONDED ABRASIVES
Paper and Cloth Combination
Sheets, Rolls, Discs
Cylinder Hones
Sticks, Stones & Rubs
Specialties

ABRASIVE GRAINS AND COMPOUNDS
for:
Polishing
Lapping
Pressure Blasting
Finishing

"Carborundum" is a registered trademark which indicates manufacture by The Carborundum Company

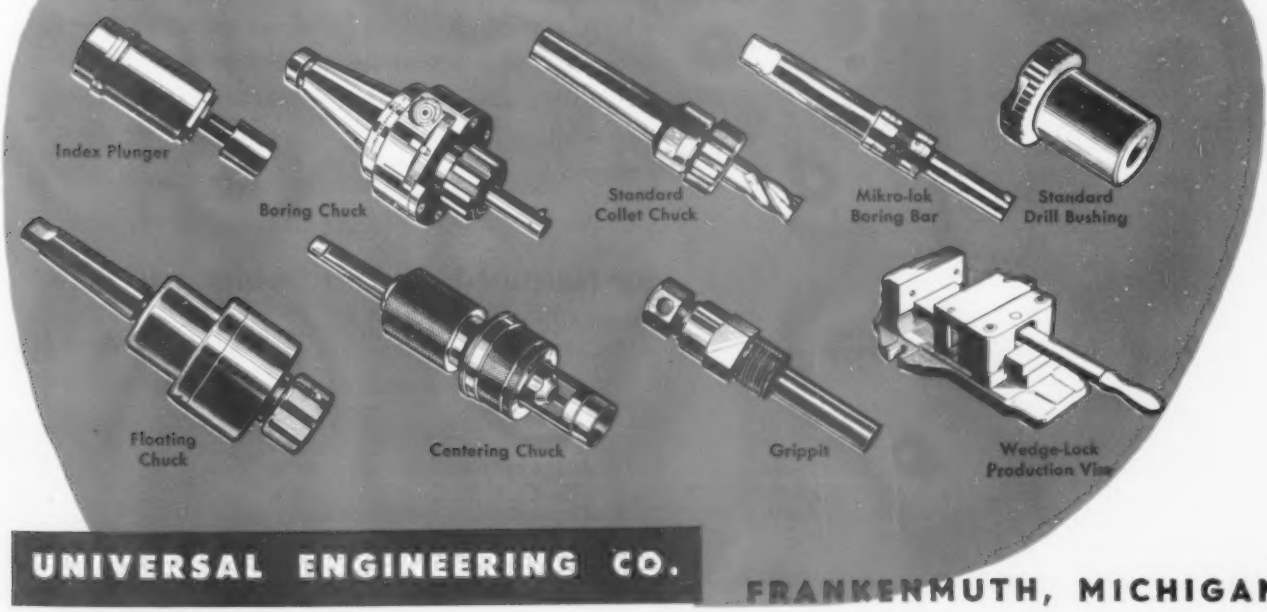
Reduce WORK CHANGE TIME FROM 10% TO 80%

SWIFT LOCKING, POSITIVE GRIP OF NEW UNIVERSAL WEDGE-LOCK VISE SIMPLIFIES SMALL PARTS PRODUCTION



It's a whiz! Just a short 15 degree pull on the lever clamps work in the Universal Wedge-Lock Production Vise. A second pull of only 7 degrees locks the piece securely, ready for machining. Taper wedges smoothly and swiftly apply pressure to adjustable jaw—reduce loading and unloading time from 10% to 80%. Available in 4", 5", and 6" jaw widths. Write for complete information on Universal Wedge-Lock Vises and other superior Universal tools illustrated.

UNIVERSAL TOOLS THAT WILL INCREASE PRODUCTION AND EFFICIENCY IN YOUR PLANT.

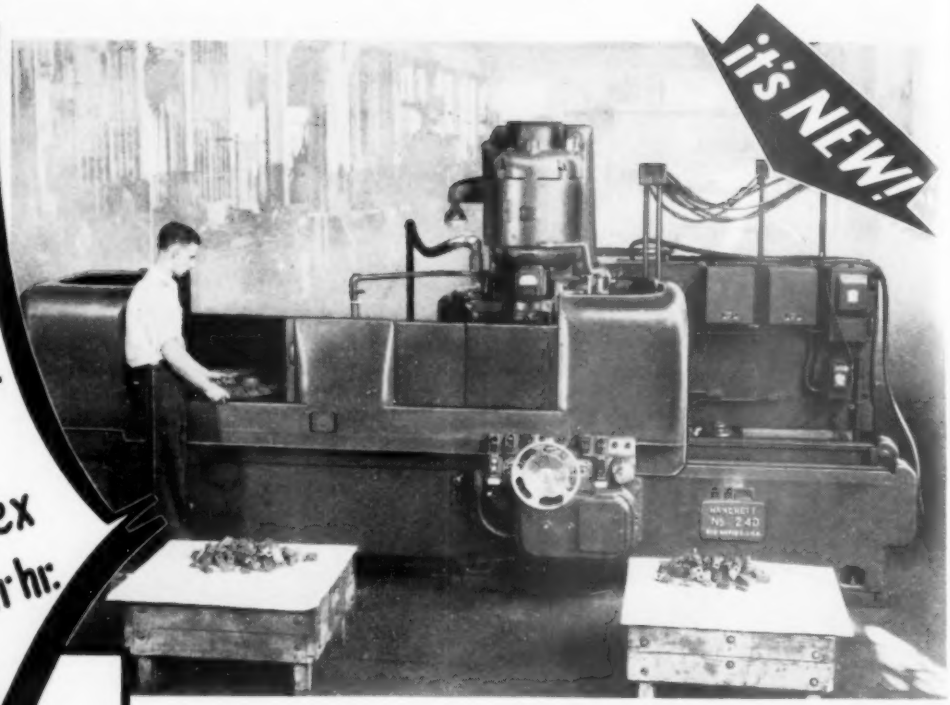


UNIVERSAL ENGINEERING CO. **FRANKENMUTH, MICHIGAN**

Compare These Figures:

~~1 operator~~
~~1 standard grinder~~
~~250 pieces per hr.~~

1 operator
1 No. 24-Duplex
500 pieces per hr.



The Job — Inserted tooth cutters. Must be ground very accurately for parallellism and size. Exceptionally fine finish. Wheel feed light to prevent heating and checking — grinding time relatively long. Chuck cleaned and loaded carefully to maintain accuracy limits. 125 pieces to a chuck. Grinding time — 15 min. Loading time — about the same.

Previous Method — Ground on single-table surface grinder. Machine *idle 30 min. of every hour,* while operator unloaded, cleaned and reloaded chuck. Production — 250 pieces per hour.

24-Duplex Method — Ground on No. 24-Duplex two-table grinder. While second load is being ground, operator unloads, cleans and reloads first chuck — No. 24-Duplex actually grinds more than 90% of the time. Production — 500 pieces per hour.

-That's PRODUCTION GRINDING on The New HANCHETT No. 24-Duplex!

Here's a practical solution to your problem of high production grinding with limited manpower. The No. 24-Duplex actually doubles output per hour—yet it requires only one operator! And the only downtime is the few seconds needed to switch from one load to the other. Productive grinding time, therefore, is more than 90% of every hour.

Added Features: Electronic-controlled variable speed unit for each rotary table . . . centralized, push-button controls . . . tilting splash guard (confines coolant to load being ground.) If you encounter a similar grinding job —where loading and grinding time are about the same—you'll want to know more about this modern, precision machine.

See Your Nearest Hanchett Dealer, or Write for Bulletin 145-2

HANCHETT GRINDERS — BIG RAPIDS MICHIGAN

IF IT'S A FLAT SURFACE—THERE'S A HANCHETT TO GRIND IT

HANCHETT MANUFACTURING CO.
BIG RAPIDS, MICHIGAN U.S.A.

HANCHETT HERMETI-COIL MAGNETIC CHUCKS

PROVEN on the job!

YOU CAN'T BUY A BETTER CUTTER THAN PLAN-CO

★ Every day the quality and performance of Plan-Co Cutters are being proven *on the job.*

See for yourself—on your own job—how Plan-Co milling and cutting tools can give you more parts per grind, more grinds per tool with exacting accuracy and exceptional finish.

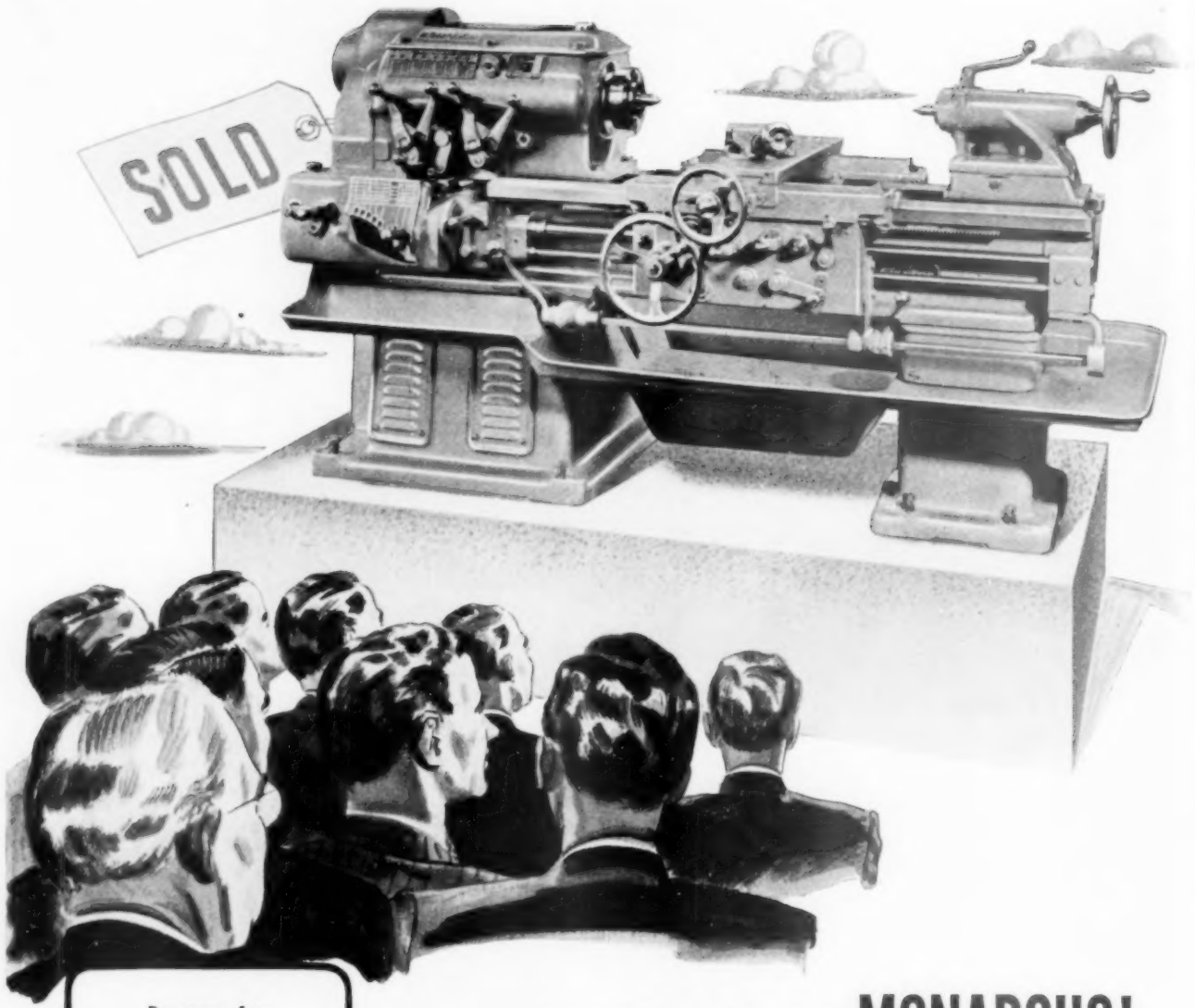
Plan-Co Cutters are produced by the makers of Plan-O-Mill form milling and thread milling machines. They are made to your own specifications or designed to fit your job. Send us your blueprints.

5 FIRSTS BY PLAN-O-MILL

PLAN-O-MILL CORPORATION
1511 E. EIGHT MILE ROAD
HAZEL PARK, MICH.

THREAD AND FORM
PLAN-O-MILL
MILLING MACHINES

MILLING AND
PLAN-CO
CUTTING TOOLS



Reasons for Monarch Popularity!

- Flame-hardened and ground bedways
- Hardened and ground parts throughout
- Anti-friction bearings
- Force-feed lubrication
- High spindle speeds
- Easy, convenient controls
- Automatic sizing
- Taper turning attachments
- Monarch-Keller controls
- Accessories to cut costs and widen range of work

ACCURACY · ECONOMY · LONG LIFE

Monarch TURNING MACHINES

EVERYBODY WANTS MONARCHS!

"SOLD" signs appear quickly on Monarch Turning Machines, whenever they are listed at surplus machine tool sales. Alert buyers recognize Monarch's ability—proved in the grueling grind of wartime service—to retain their original accuracy, speed and high quality of production.

They know that flame-hardened and ground bedways and bearing surfaces, anti-friction bearings, force-feed lubrication and other important features enable Monarchs to turn more and better work at lower cost . . . for a long time.

So, when you hear of a surplus Monarch, you'd best move quickly. Ask our nearest office to check the machine with you, and to tell you about accessories and tooling that will help you gain the greatest benefit from your purchase. There is no cost or obligation for this service, so use it freely.

THE MONARCH MACHINE TOOL COMPANY • SIDNEY, OHIO

FACTORY BRANCHES:

622 West Washington Blvd.
Chicago 6, Ill.
801 Fisher Building
Detroit 2, Mich.

10465 Carnegie Ave.
Cleveland 6, Ohio
635 Industrial Office Bldg.
Newark 2, N. J.

512 Empire Building
Pittsburgh 22, Pa.
38th and College Ave.
Indianapolis, Ind.

Representatives in Principal Cities

SIMONDS
SAW AND STEEL CO.
FITCHBURG, MASS.

YOU WILL NOW FIND THIS MARK ETCHED ON ALL THESE FINE PRODUCTION TOOLS FOR CUTTING METAL, WOOD, PAPER, PLASTICS

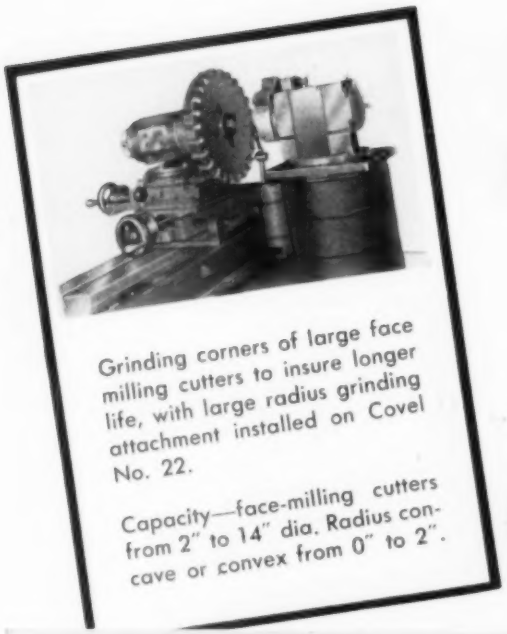
From now on, all Simonds Saws for cutting wood, metal, and plastics . . . all Simonds Machine Knives for cutting wood, veneer, and paper . . . all Simonds Red Tang Files . . . all Simonds steel and steel specialties . . . *every one* of these first-quality products will bear the same mark of family-identity you see above. And a like mark will also identify the products of Simonds Abrasive Company of Philadelphia (formerly the Abrasive Company), of Simonds Canada Saw Company, and of Simonds Steel Mills at Lockport, New York.

So now, when you want fine tools for cutting and grinding, this ribbon-etch . . . signature of America's longest experienced firm of sawmakers . . . tells you at a glance: "There's no finer tool made in this line . . . *anywhere.*"

SIMONDS rhymes with diamonds

. . . and Simonds Tools cut with diamond-like smoothness and precision. Order from your Industrial Supply Distributor or dealer, or write the nearest Simonds office:

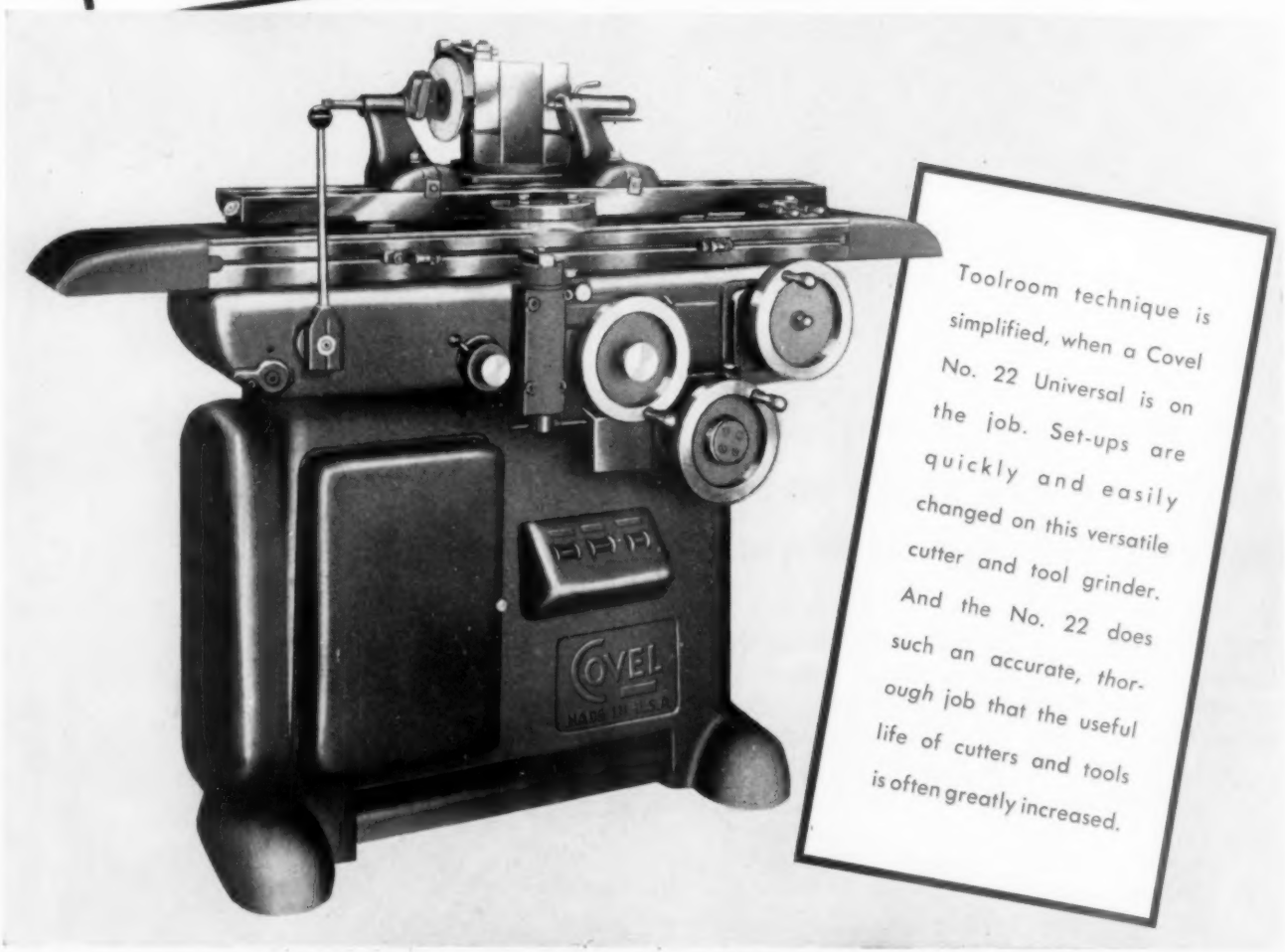
BRANCH OFFICES: 1350 Columbia Road, Boston 27, Mass.; 127 S. Green St., Chicago 7, Ill.; 416 W. Eighth St., Los Angeles 14, Calif.; 228 First St., San Francisco 5, Calif.; 311 S. W. First Ave., Portland 4, Ore.; 31 W. Trent Ave., Spokane 8, Washington.
Canadian Factory: 595 St. Remi St., Montreal 30, Que.



Grinding corners of large face milling cutters to insure longer life, with large radius grinding attachment installed on Covel No. 22.

Capacity—face-milling cutters from 2" to 14" dia. Radius concave or convex from 0" to 2".

WORN CUTTERS AND TOOLS
GET BACK INTO ACTION
F-A-S-T
WITH THE
COVEL No. 22 UNIVERSAL



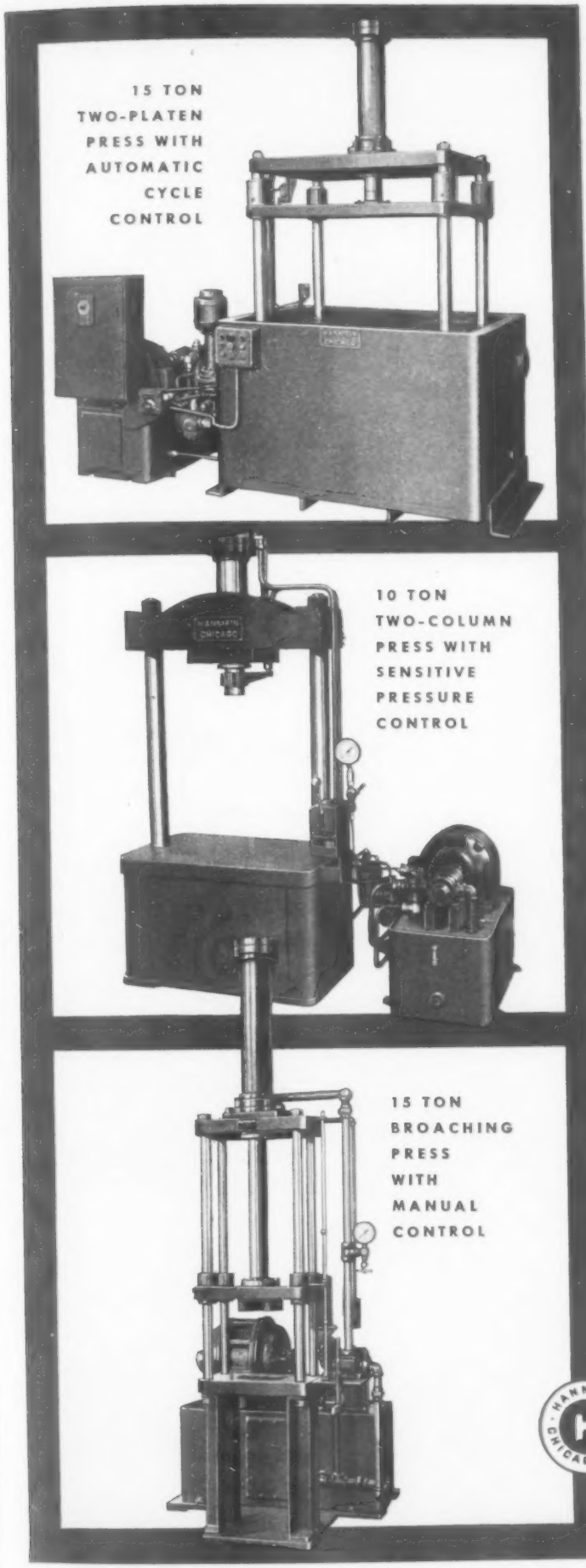
Toolroom technique is simplified, when a Covel No. 22 Universal is on the job. Set-ups are quickly and easily changed on this versatile cutter and tool grinder. And the No. 22 does such an accurate, thorough job that the useful life of cutters and tools is often greatly increased.

See Your Nearest Covel Dealer or Write for Bulletin T-16

GRINDING MACHINERY SINCE 1874

COVEL INDUSTRIAL GRINDERS

COVEL MFG. CO., BENTON HARBOR, MICHIGAN U. S. A.



VARIATIONS IN PRESS DESIGNS . . .

with the advantages of standardization

Many of the features of Hannifin Hydraulic Presses are standardized . . . perfected by long experience . . . providing the obvious advantages of simplicity, economy, and rapid production. These designs include welded frames and bases, standard hydraulic cylinders and hydraulic power units and perfected controls.

Flexibility to meet individual needs allows Hannifin engineers to provide exactly the right press for your work, without the delays incident to special design. Column spacing gap, ram stroke, table construction, speeds and controls may be readily modified to suit individual requirements. The column type presses shown here are typical examples.

The 4-column press has two platens, one moving up from below. Space between columns is 42 x 32 inches. Capacity is 15 tons. Ram strokes and pressures are adjustable, and the controls provide an automatic cycle.

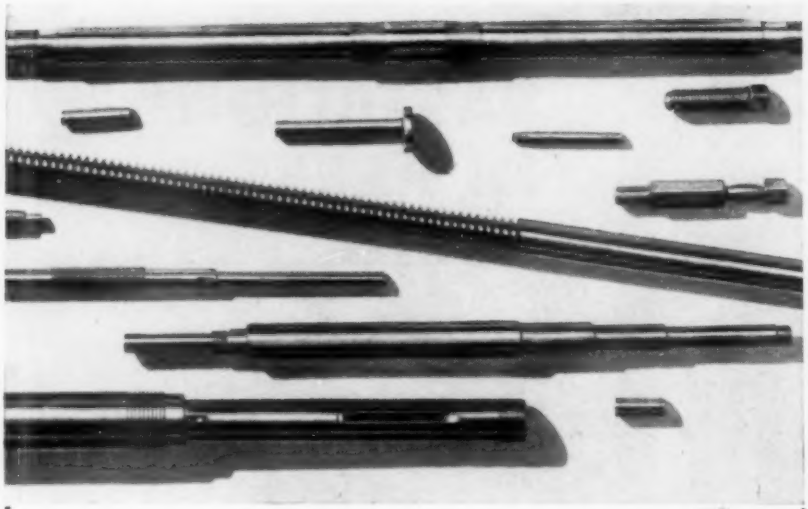
The 2-column press is 10 ton capacity, 12 inch stroke, table 30 x 26 inches. This press has the exclusive Hannifin Sensitive Pressure Control for accurate pressing and assembly operations.

The 4-column long stroke press is designed for a variety of broaching operations. It has manual control with automatic stops, adjustable stroke up to 30 inches maximum, and capacity of 15 tons.

Hannifin Hydraulic Presses are available in 2, 3, 4 column and open gap types, capacities 5 tons to 150 tons, for straightening, forming, press assembly, and similar operations involving the application of pressure. Descriptive bulletins will be sent upon request.

Hannifin Manufacturing Company, 621-631 South Kolmar Avenue, Chicago 24, Illinois.

Hannifin
HYDRAULIC PRESSES



Take the "Short Cut" from Bars to Better Finished Parts with

STRESSPROOF

T. M. Reg. U. S. Pat. Off.

NO HEAT TREATING OR CARBURIZING is necessary in most parts made from STRESSPROOF Cold Finished Steel Bars. Machine 'em, and they are ready – because the qualities you need are *right in the bar!*

MACHINE EASIER, too, and with less warpage than the alloy steels they often replace, at a lower material cost, with directly comparable service life. Used in place of regular cold drawn shafting, STRESSPROOF often doubles the wear.

FOR REPAIR PARTS, there's nothing better or easier to use. Try it – compare the work-saving and wearability. You'll see why it's your "short cut" to lower costs. Available from Milne warehouse stocks.

SAME STRENGTH IN CENTER

Comparatively uniform Brinell hardness throughout the cross section of the bar. When outer surface of STRESS-PROOF is machined away, no strength is sacrificed as the steel has remarkable uniformity of properties from center to outside.

FREE – the complete story of STRESSPROOF and the many ways it can save for you. Ask a Milne representative, or write or phone any address below for your copy.

A. MILNE & CO.

ESTABLISHED 1887

★ NEW YORK 14
741 Washington St.

★ BOSTON 9
109 Broad St.

★ PHILADELPHIA 6
337 No. Orianna St.

★ FIVE CONVENIENT WAREHOUSES CONNECTED BY BELL SYSTEM TELETYPE

★ CHICAGO 7
17 N. May St.

★ PITTSBURGH 19
604 Frick Bldg.

WASHINGTON 4, D. C. OFFICE
900 F St., N. W.

Get it FASTER from STOCK from MILNE

KOLORKOTE
TOOL STEELS
High Speed, Alloy, and Carbon

HOLLOW, SOLID, AND AUGER
DRILL STEELS
for all mining and excavation work

BYERS GENUINE WROUGHT IRON BARS
To A.S.T.M. Specification A-189
To A.A.R. Specification M-302
To U. S. Navy Specification 46-1-7C of May 1, 1944

TIMKEN
GRAPHITIC STEELS
Machine Faster
Wear Longer

STRESSPROOF
T.M. Reg. U.S. Pat. Off.
STEEL
COLD DRAWN – FURNACE TREATED
"More than just strain-relieved."
"HIGHER IN-THE-BAR PHYSICALS"

NITRALLOY TYPE G 135 MODIFIED (AIRCRAFT) TO AMS 6470-A

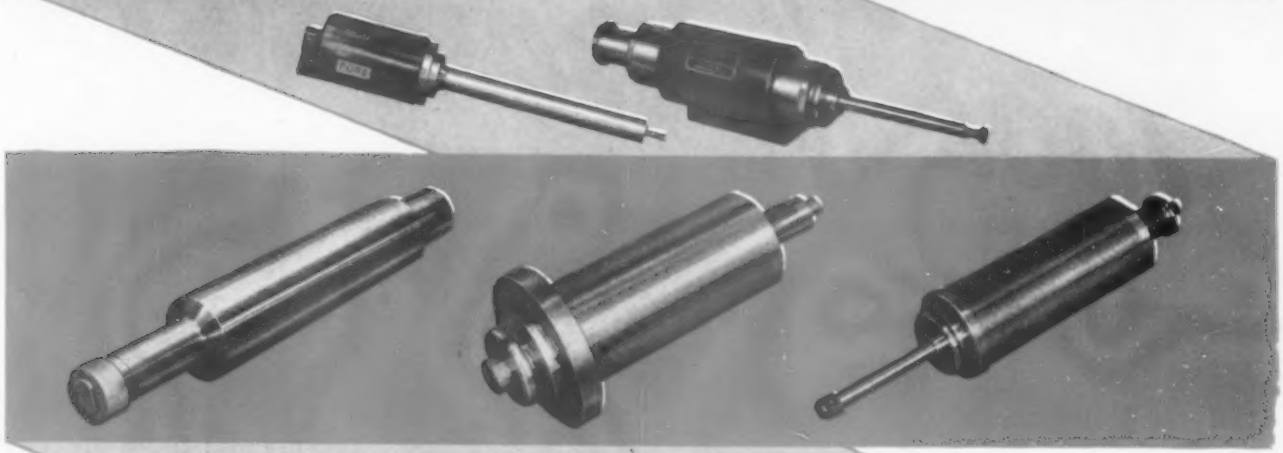
also carried in Warehouse Stock.

INTERNAL GRINDING SPINDLES

designed and built by

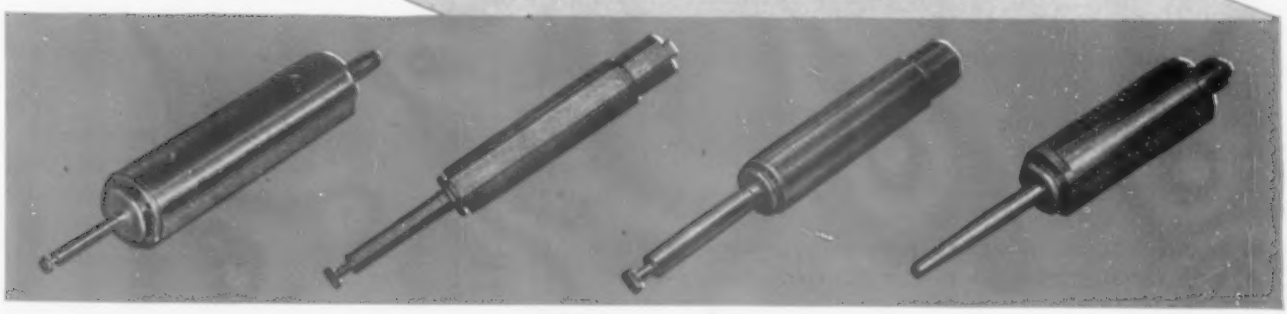
POPE

with lubrication Sealed-In



BETTER FINISHES and MORE ACCURATE DIMENSIONS
can be maintained with

POPE PRECISION SPINDLES



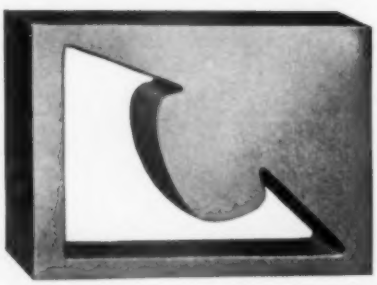
Send us sketch or outline drawing of the spindles you require.
We will be glad to submit recommendations and quotations.

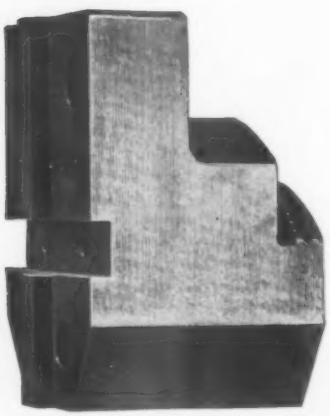
No. 29

POPE

POPE MACHINERY CORPORATION
ESTABLISHED 1920
261 RIVER STREET • HAVERHILL, MASSACHUSETTS
BUILDERS OF PRECISION SPINDLES

BTR IS A Safe-Hardening TOOL and DIE STEEL





A steel that hardens safely—that quenches without cracking—is like money in the bank to the tool- and die-maker. That's why Bethlehem Tool Room (BTR) is the recognized leader in its field.

When there are drastic dimensional changes in the die or punch—when there are sharp, angular corners or round corners with small radii—when there are many holes separated by thin webs—play safe and insist on BTR.

Its safe-hardening characteristics are due in part to the following reasons:

(1) Balanced analysis of manganese, chrome, tungsten, and vanadium.

(2) Ability to oil-harden at relatively low temperatures.

Here is a steel that holds its size and shape in the heat-treating process. You'll find, too, that in the ideal quenching and tempering range, it hardens to a Rockwell C of 62-63. Moreover, it is easy to machine and is high in both wear- and shock-resistance.

BTR is an old, reliable performer. To minimize cracking dangers, always make sure that it's stocked in your tool room.

TYPICAL ANALYSIS:

C	Mn	Si	Cr	W	V
0.90	1.20	0.30	0.50	0.50	0.20

BETHLEHEM STEEL

BETHLEHEM TOOL ROOM . . . one of Bethlehem's *Big 8* Tool Steels

THIS VERSATILITY

Also Has Many POSTWAR USES

The myriad requirements of war demonstrated the amazing versatility of Vickers Hydraulic Controls. There were so many kinds of jobs to do—jobs which had to be done better than ever before—jobs which had never previously been accomplished.

For example, in this illustration, the plane has Vickers Hydraulic Control for brakes, automatic pilot and cargo door operation. The lift trucks have Vickers Hydraulic Control which lifts and positions the load accurately at the finger-touch of the operator. The graders building air fields use Vickers Hydraulic Power for steering front and rear wheels, raising, lowering or side shifting the blade, and operating the attachments.

These are just a few of the war jobs Vickers Hydraulics have done. Others include the precision movement of heavy battleship turrets—the automatic aiming of anti-aircraft guns—the fast precision positioning of ammunition hoists—the control of bomber gun turrets—and others which, cannot yet be described.

Many of the intricate machine tools that produced the machines that won the war depended for their accuracy, production speed, and ease of operation upon Vickers Hydraulic Controls.

This demonstration of the remarkable versatility of Vickers Hydraulic Controls suggests many new applications to a wide variety of postwar equipment.

VICKERS HYDROMOTIVE EQUIPMENT

VICKERS *Incorporated* • 1416 OAKMAN BLVD • DETROIT 32, MICH.

Application Engineering Offices:

Chicago • Cincinnati • Cleveland • Detroit • Los Angeles • Newark • Philadelphia • Rochester • Rockford • Tulsa • Worcester

There are more than 5000 Standardized Vickers Units that can be used in various combinations to exactly supply Every Hydraulic Power and Control Function

ANY FEED RATE · ANY TRAVERSE RATE · ANY R P M
ANY SEQUENCE OF MOTIONS · ANY ACCELERATION OR DECELERATION · ANY THRUST . . . . . .

GEROTOR DOUBLE UNIT **PUMPS**

DON'T HAVE A ONE TRACK MIND

They're really VERSATILE!—precision engineered for a wide variety of applications using hydraulic oil circuits. That's one of the reasons why you'll find Gerotor pumps specified as standard equipment on many important industrial machines.

This double unit model supplies two separate oil flows, and the flexibility is such that each pump section has its own independently controlled output.

If you have a pump problem that calls for versatility—as well as dependability—call for

GEROTOR

GEROTOR MAY CORPORATION • BALTIMORE 3, MD. ★ Plants at Logansport, Ind. • Baltimore, Md.

P and J AUTOMATIC CHUCKING and TURNING MACHINES

So that you may have the latest data on these MODERN, HIGH PRODUCERS of DUPLICATE PARTS

The advantages, features and capacities of Potter & Johnston Automatic Chucking and Turning Machines are clearly and concisely described in the five bulletins illustrated here. They cover the following machines:

Type 4D Automatic — Swing over bed 21" (Bulletin 112)

Type 5D Power-Flex Automatic (Bulletin 122)

Type 5D-2 Two Spindle Power-Flex Automatic in 9", 12" and 15" Models (Bulletin 123)

Type 6D REL—Automatics—Swing over bed 34½" (Bulletin 118)

Type 8 DXT—Automatics—Swing over bed 36" (Bulletin 112)

Any or all of these bulletins will be sent promptly without obligation. Kindly use your company letterhead in making your request.

Remember We still have an obligation — to buy Victory Bonds.

STAINLESS STEELS

. . . most versatile of modern metals
. . . their unique combinations of
properties merit your consideration
in designing for the future

THIS STAINLESS-CLAD STEEL PIPE...

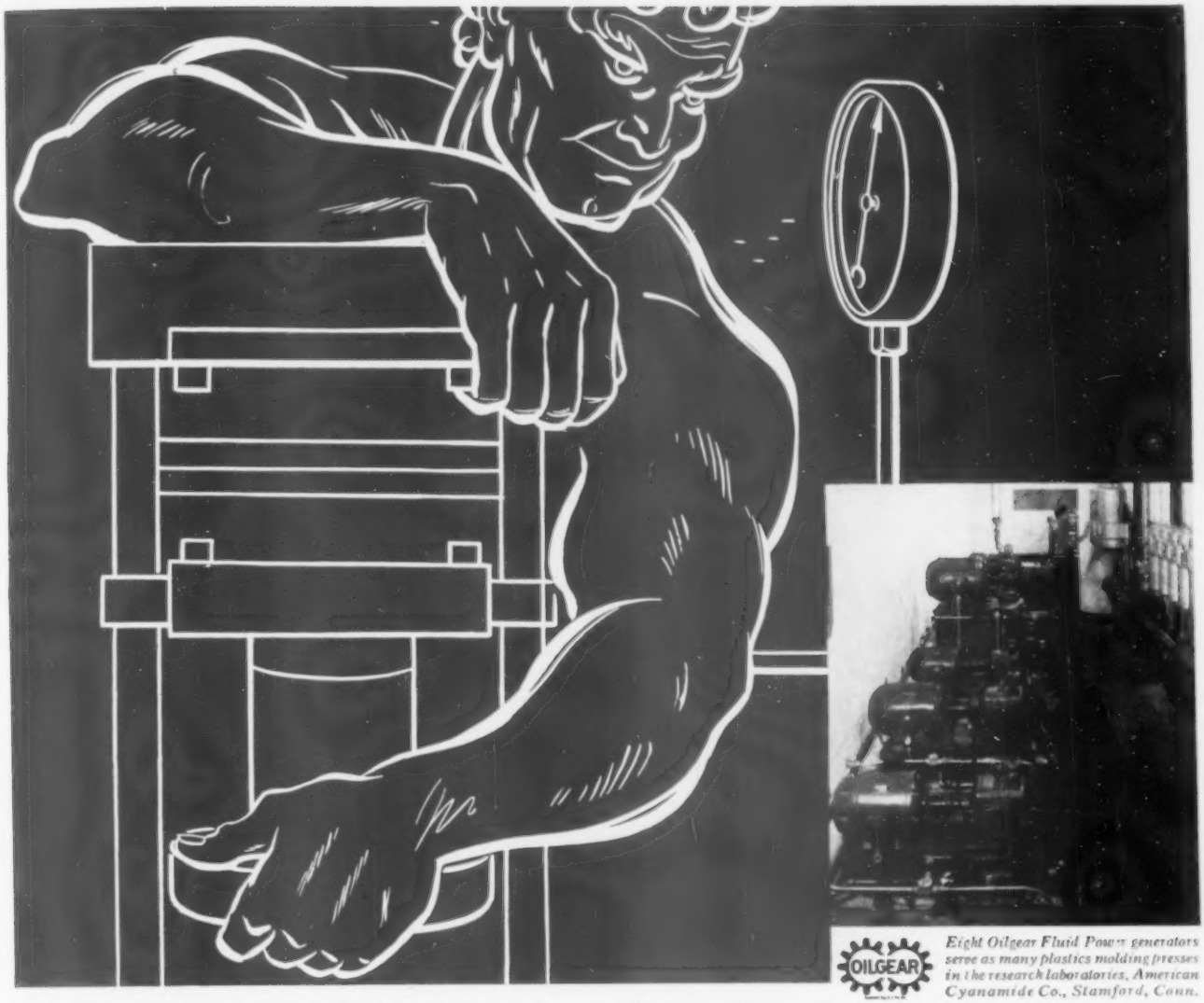
Gives long, satisfactory service under high temperature annealing conditions

In constant service since 1941 . . . this stainless-clad steel annealing tube presents a striking contrast to its two companions of low carbon steel. The Jessop Steel Company, Washington, Pa., uses these pipes for annealing tool steel bars. After approximately ten anneals, scaling and distortion rendered the carbon steel pipes useless. After over 300 anneals, the stainless-clad steel pipe *still showed no signs of deterioration.*

The stainless used for cladding is of the low carbon-chromium-Nickel type produced by Jessop themselves.

International Nickel are miners, smelters and refiners of Nickel, an important ingredient in stainless steels, but do not produce stainless steels. A list of sources of supply for chromium-Nickel stainless steels will be furnished upon request.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 Wall Street New York 5, N. Y.



Eight Oilgear Fluid Power generators serve as many plastics molding presses in the research laboratories, American Cyanamide Co., Stamford, Conn.

Here, Oilgear Fluid Power points the way to better plastics products

Can precision control of power help you in experimental, design or production work?

There apparently is no end to the ways in which versatile Oilgear Fluid Power can help industry turn out better products. In the Stamford, Conn., Research Laboratories of the American Cyanamide Company for example, Oilgear's smooth, infinitely variable and precisely controllable power and speed are helping plastics research fully to investigate and compare the characteristics of various plastics throughout the full pressure range.

One of many desirable press cycles possible with Oilgear Fluid Power is: quick closing of platen a preset distance . . . maintaining a preset pressure for a preset time with low power input . . . quick opening of platen a short preset distance . . . quick closing of platen . . . gradual pressure increase at an adjustable rate with low power input . . . quick opening of platen to loading position.

Whether you want stepless increments of power or speed, or precision control manually or automatically . . . whether you want complex combination of functions or a more conventional solution to rotary or straightline transmission problems, you *should* investigate Oilgear Fluid Power without fail and without delay. Know more about this pliant power so easily molded to your needs. Write today. THE OILGEAR COMPANY, 1303 W. Bruce St., Milwaukee 4, Wisconsin.

Oilgear Fluid Power

ARE YOU TRYING TO:

1. Apply large forces through long . . . or short . . . strokes at variable speeds? **2.** Obtain automatic work cycles, variable speeds in either direction . . . with or without preset time dwell? **3.** Apply large forces through continuous or intermittent reciprocating cycles at constant or variable velocities? **4.** Obtain extremely accurate control of either position or speed of a reciprocating member? **5.** Apply accurately variable pressure either static or in motion? **6.** Closely synchronize various motions, operations or functions? **7.** Apply light . . . or heavy . . . forces at extremely high velocities through either long or short distances of travel? **8.** Obtain continuous automatic reversing drives at constant R.P.M. or over a wide range of speed variation? **9.** Obtain accurate remote control of speed and direction of rotation, rates of acceleration and or deceleration? **10.** Obtain constant horsepower output through all or part of a speed range? **11.** Obtain automatic torque control? **12.** Obtain accurately matched speed of various rotating elements? **13.** Obtain constant speed output from a variable speed input? **14.** Obtain full preset automatic control, elimination of problems of shock, vibration, etc.?

You Need Oilgear!

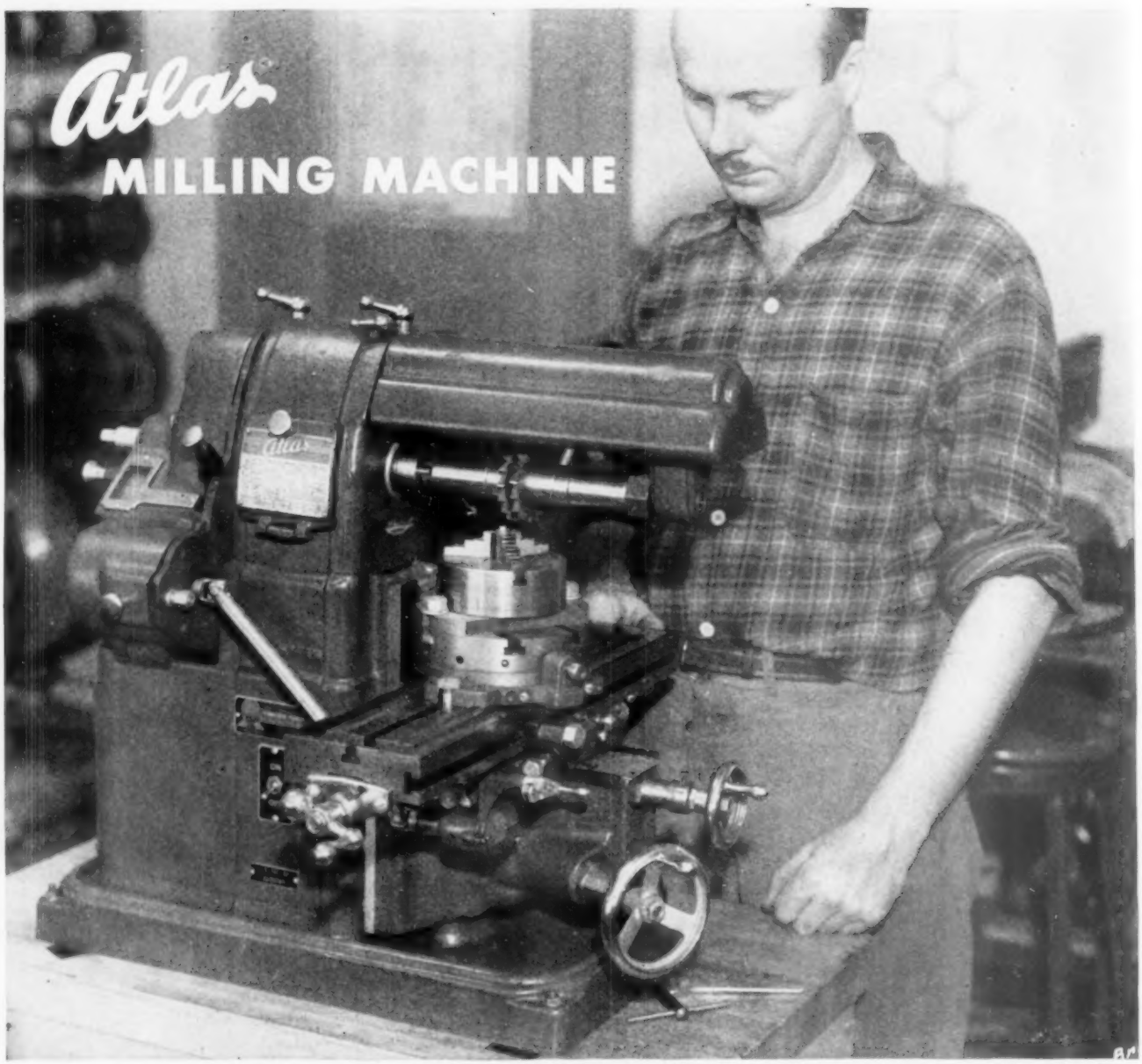


Photo Courtesy Miller Electro Research Laboratories, Milwaukee, Wis.

QUICKER, MORE EFFICIENT on Small Parts Operations

YOU CAN save a lot of set-up time and effort — in the tool room or on the production line — with this compact Atlas milling machine.

Any part that comes within its 4½" x 18" table traveling 10" longitudinally and 3½" cross-table, can be milled to close tolerances quickly and easily. There are eight spindle speeds from 62 to 2870 RPM. Three types of table controls are available — manual, lever, or Change-O-Matic. Adding air chuck and control devices gives you a semi-automatic machine capable of surprising production records.

The Atlas milling machine, like the rest of the Atlas 4 Tool Team, helps you "match the machine to the job" to lower machine-hour costs and eliminate wasting the capacities of large machines. Send for latest catalog.

ATLAS PRESS COMPANY, 114 N. Pitcher St., Kalamazoo 13D, Michigan.

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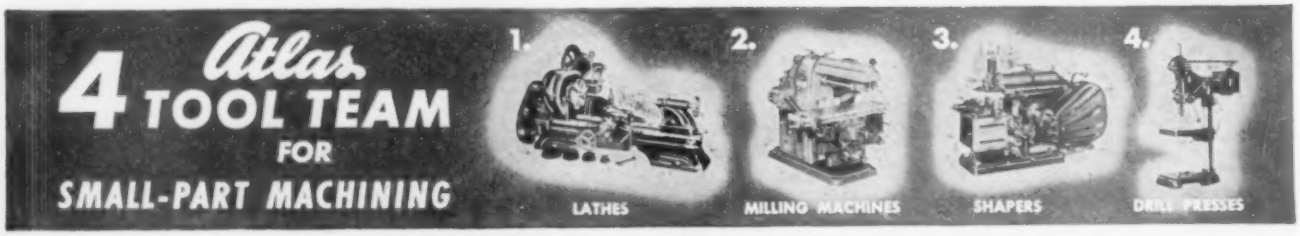
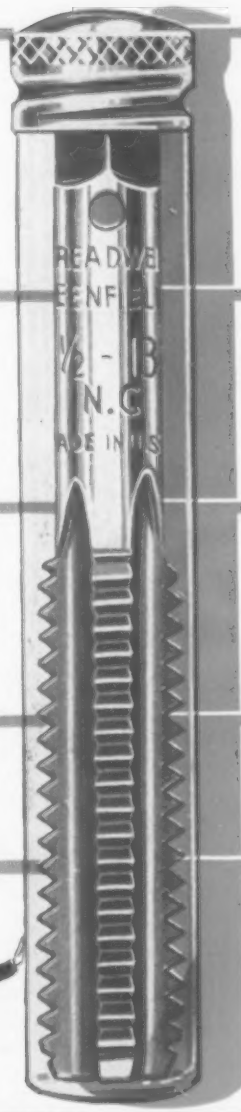


CHECK *Your* TAPS ON THESE 5 COUNTS

Your high speed taps may be well and accurately made. But why let it go at that when, today, you can get so much more for the same money. Before you buy, ask yourself these questions:



1 Are They COLD-TEMPER Taps?

Deep-freeze treatment at 120° below zero in addition to the usual heat treatment makes taps stronger but less brittle. COLD-TEMPER Taps produce cleaner, better threads and more of them per tap —not only on steels, cast iron and alloys, but on plastics and other abrasive materials.

Only *Threadwell* Taps are COLD-TEMPER Taps.

2 Are They Color "i-dot-ified"?

Taps look alike. Errors in tap selection are avoided by modern use of color identification—*red* dot on the shank for cut thread, *white* dot for commercial ground, *blue* dot for precision ground.

Only *Threadwell* Taps have "i-dot-ification."

3 Are They Individually Plastic Packed?

Taps are precision tools. They merit complete protection against dirt, dust and damage. Transparent plastic provides perfect individual protection and permits ready selection without unwrapping.

Only *Threadwell* Ground Thread Taps come in the metal-capped *tap-capsule.*

4 Are They Greaseless Rust-Proofed?

For speed and convenience, taps should be clean and dry to handle.

Threadwell taps have a special greaseless rust-proofing.

5 Are Your Tap Needs Given Personal Attention At the Factory and By Your Supplier?

Threadwell personal attention service applies to every order, large or small. The Threadwell distributor in your locality has been carefully selected for his ability to provide that kind of service. May we put you in touch with him?

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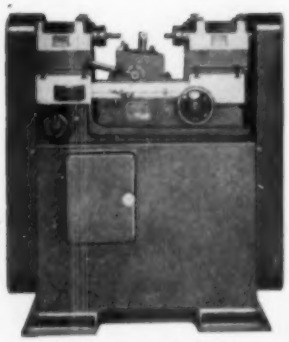
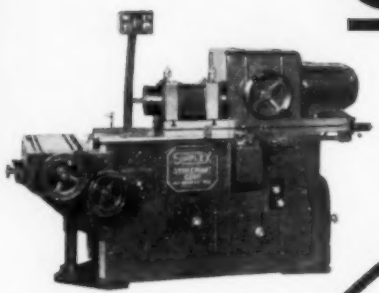
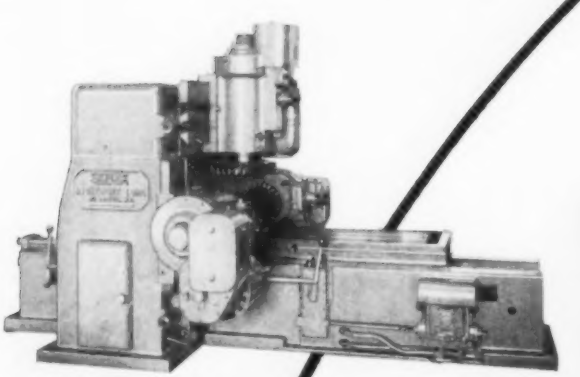


SIMPLEX 1LD1 Precision Boring Machine

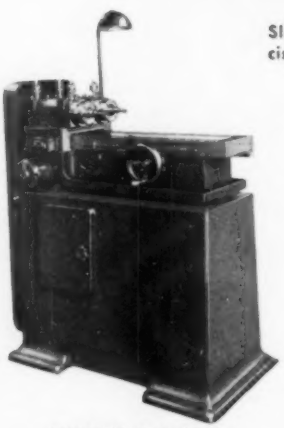


SIMPLEX 3U Knee Type Precision Boring Machine

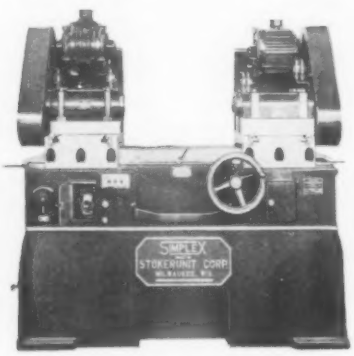
SIMPLEX 2U 3-way Precision Boring Machine



SIMPLEX Planer Type Milling Machine



SIMPLEX 1L1 Precision Boring Machine



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Present day manufacturing methods demand PRECISION TOLERANCES, combined with HIGH PRODUCTION possibilities for machine tools. SIMPLEX design meets these requirements in every respect.

Whether your problem is a single, close tolerance boring job — a multiplicity of operations involving rough and precision boring — or a heavy milling job — there is a SIMPLEX machine to fill your needs. A wide range of types and sizes of precision boring machines and planer type milling machines are available for this purpose.

An Engineering Department experienced in the many new methods so recently developed is at your disposal and ready to assist in gearing industry for the days ahead.

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SIMPLEX Machine Tools Division

4528 West Mitchell Street, Milwaukee 14, Wisconsin

Precision Boring Machines, Planer Type Milling Machines and Special Machine Tools

Memo to the Metal Working Industries

When you measure productive value in terms of unit cost, these Gairing heavy duty inserted blade cutter heads are symbols of metal working economy.

Bodies are of heat treated chrome vanadium steel. The Gairing method of mounting recommended types of inserted blades assures quick adjustment and renewability; provides for three-way strain: shock load, radial pressure and thrust. Chip egress and cutting clearances are engineered to meet specific conditions.

These four Gairing cutters are typical of thousands in use throughout the metal working industries. The names of the firms who purchased them are an index of industrial America.

Let us assist you.

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AVAILABLE NOW THROUGH RFC

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This is an unusual opportunity for many manufacturers to get ahead in their reconversion program. While some of the sizes, shapes and alloys of the RFC stock of surplus steel may differ from the specifications of normal industry requirements, it has the advantage of being quickly available.

Attractive allowances have been made in our pricing program to move this steel into the hands of private industry.

HOT ROLLED PLATES

Carbon and Alloy. Wide range of sizes from ¼" to 6" thick, up to 96" wide.

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7,000 tons. In Water-hardening, Oil-hardening and High Speed grades. Large range of bar sizes.

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Available in Hot Rolled and Cold Rolled, Carbon and Alloy. Large quantity of High Carbon Cold Rolled Strip—to be sold at low Carbon prices—or lower. Large range of sizes.

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Hot Rolled and Cold Finished in both Carbon and Alloy. Rounds, squares, flats and hexagons in various specifications. Many items in large quantities.

Write, wire or phone your requests to the nearest RFC agency listed below for more detailed information. If you desire, credit terms can be arranged. If your local office does not have all the materials you need, it will endeavor to locate them from other offices throughout the country.

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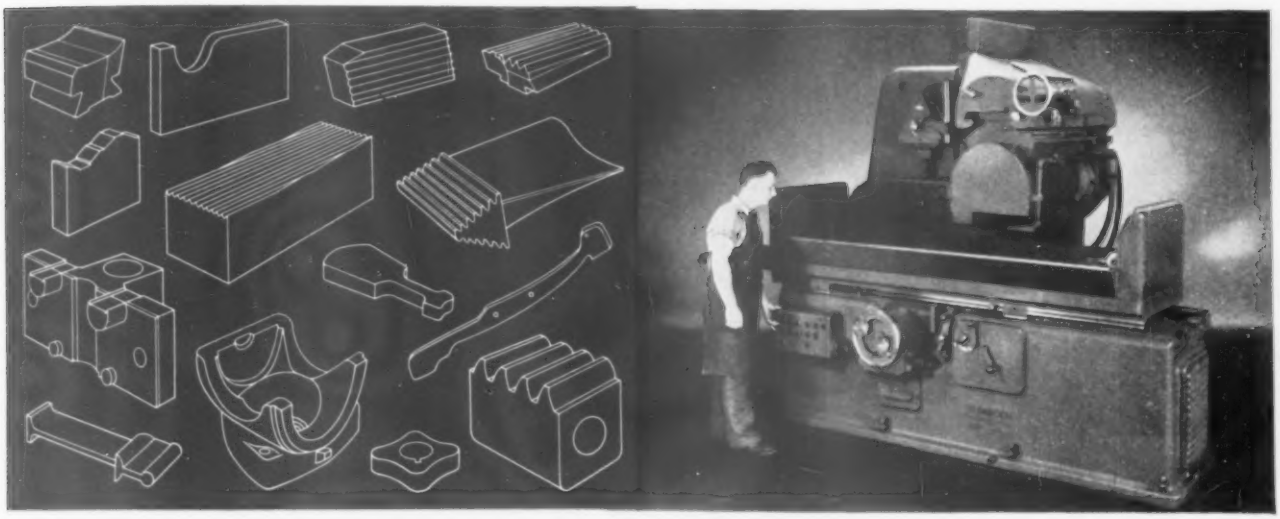
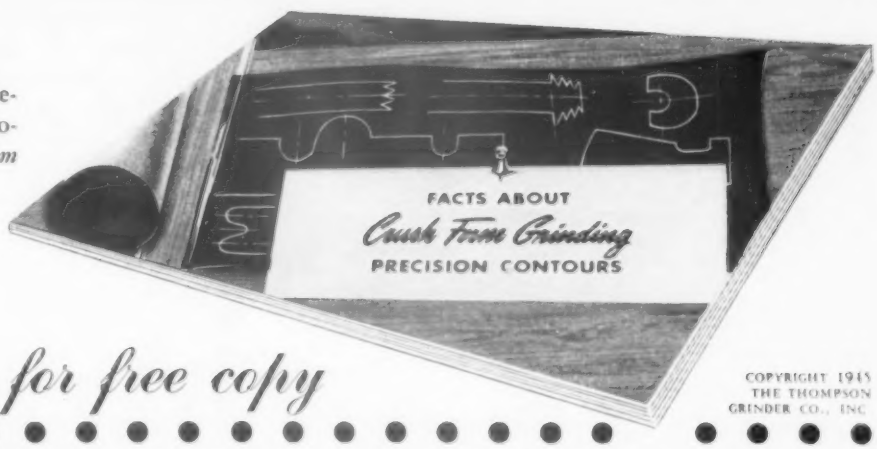
to all interested in production of precision flat form contours

1. Contours like these can be produced more economically and accurately by a proven crush form grinding process known as *Thompson Truforming.* (REGISTERED TRADEMARK)

2. The ONLY machine that is *completely engineered and built* for crush form grinding precision contours is the new *Thompson Truform Grinder.*



3. To meet individual requirements, various types of automatic *Thompson Truform Grinders* are available. For advantages and complete pictorial production explanation send for this new book.



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TAPPING TIPS

From Woody Spencer's Notebook

Give 'Em the Whole Story

Way back when I was a kid in school I used to have to write over and over from the copybook "A little knowledge is a dangerous thing." Never thought then it would apply to taps. But it sures does. One of the pet gripes from my tool crib friends is that the boys in the shop don't give 'em enough information on a tap job. Then, when the tap don't work, they get the kick back. Works the same way when ordering taps too. Best thing is to give all the information possible. What kind of material? Is it a blind hole or a through hole? What's the diameter, the depth? What tolerance? That's the information that decides style of tap, number of flutes, champfers and all the details that work together to give a fast, smooth tapping job.

Woody's Tapping Tips are by no means intended as technical advice on tapping. They are merely a collection of hints, ideas, suggestions and shop short cuts gathered by Woody in his travels among shops all over the country. Their real purpose is to smooth out and speed up routine tapping jobs, save time and cut rejects.

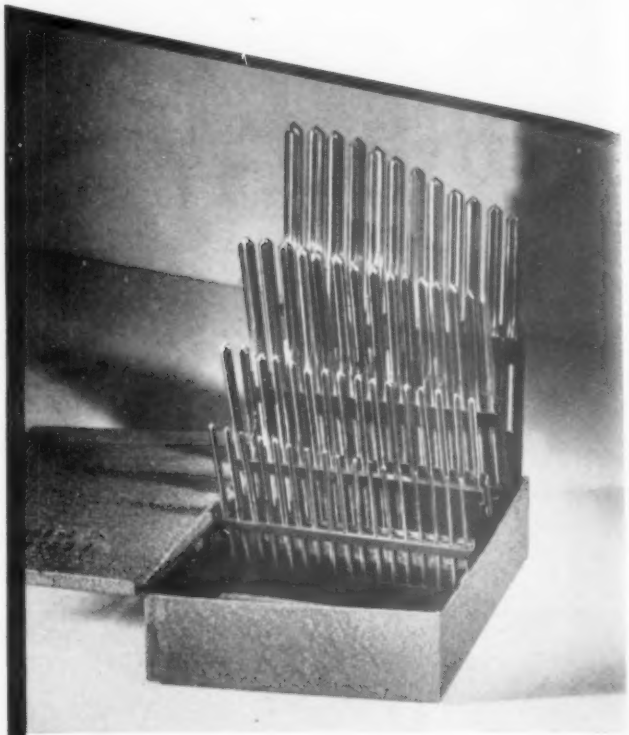
Where specific problems come up, definite engineering advice should be obtained. If you will send complete data on a job—material, depth, diameter, lubricant, etc.—our engineers will be glad to make recommendations. No obligation, of course.

Note — Woody Spencer's Tapping Tips are appearing here as often as Woody gets time to write them up. Look for them.

Woody Spencer's new Tap Guide is full of handy information that will help in tapping operations. It's Free. Write for your copy on the company letterhead.

THE RIGHT TAP AT THE RIGHT TIME

The Wood & Spencer Company
Cleveland 3, Ohio



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They're better, because L & I specializes in ground flute reamers — ground *after* the solid bar is heat-treated and uniformly hardened. This gives a perfect cutting edge that stands up far longer than ordinary milled flute reamers.

Because we're "Specialists in Small Reamers," we ship from stock Machine Reamers by 64's from 1/16" to 5/16" and Wire Gage sizes 1 through 60, as well as Taper Pin Reamers from 7/0 to #4.

Place a trial order today and join the long list of leaders who are cutting costs and improving work quality with L & I Ground Flute Reamers.

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2

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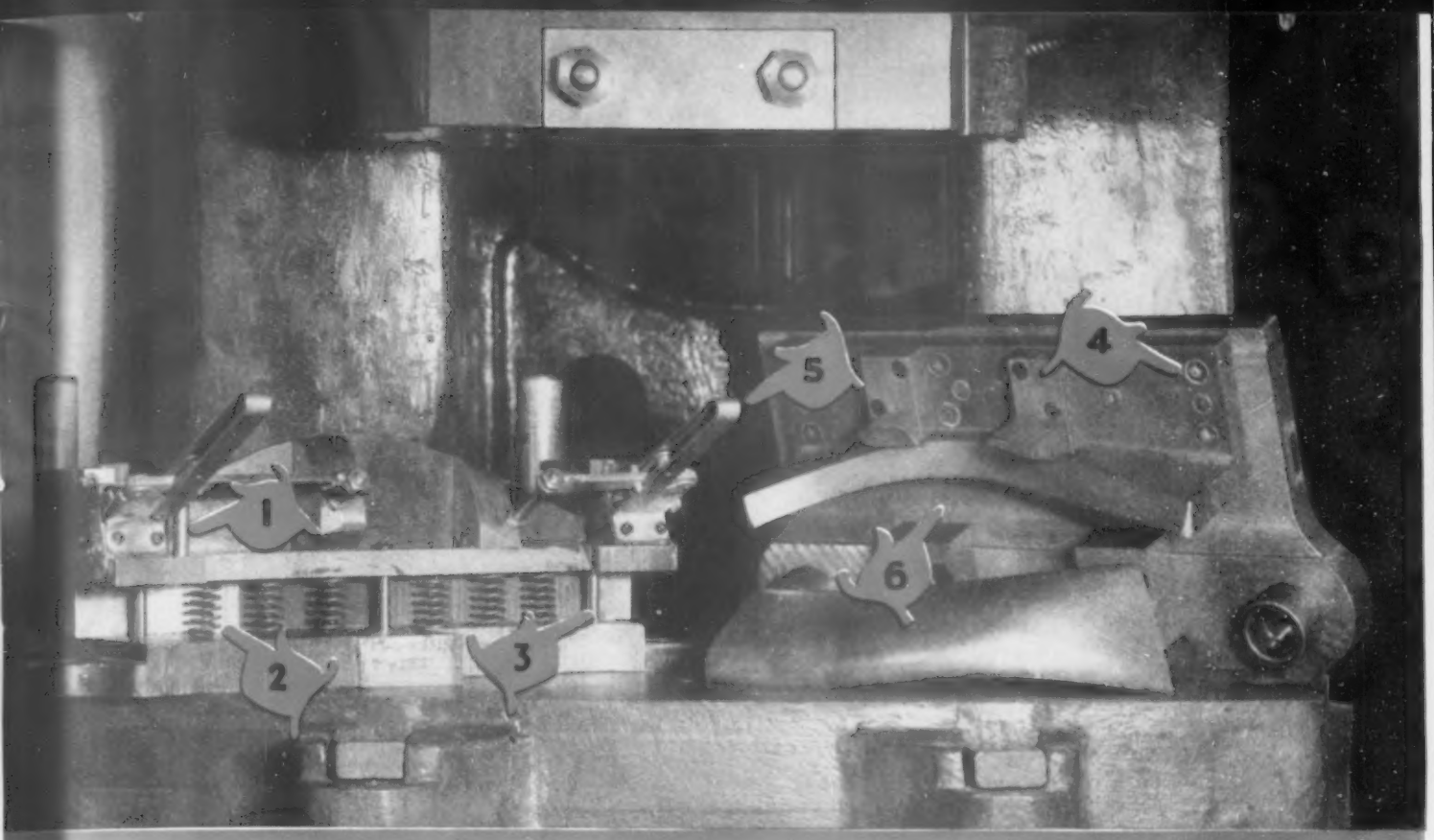
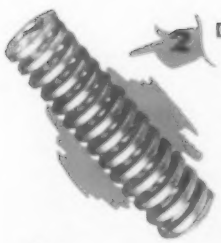


THE 6 DANLY PRODUCTS IN THIS PICTURE

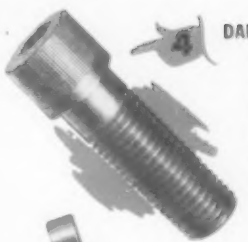
FIT INTO MANY PLACES IN YOUR PICTURE

1 **DANLY PRECISION DOWEL PINS** have a big job to do in the Steel, Non-ferrous metals and Plastic Industries. Accurate through their length, there will be no expensive re-drilling and reaming, because Danly Precision Dowel Pins are diamond tested for hardness and ground to a tolerance of one-ten thousandth of an inch . . .



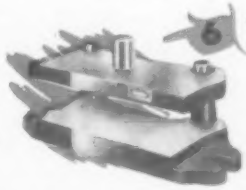
2 **DANLY DIE SPRINGS** are noted for *staying power*. The repeated pressure of the ram many times every hour induces fatigue that will snap ordinary die springs—and that means tearing down the whole setup. Two complete lines. *MEDIUM PRESSURE—HIGH DEFLECTION; HIGH PRESSURE—MEDIUM DEFLECTION.*

3 **DANLY SOCKET-HEAD STRIPPER BOLTS** incorporate the same advantages as the Danly Knurled Socket-Head Cap Screws. Busy fingers don't slip on the knurled head . . .



4 **DANLY KNURLED SOCKET-HEAD CAP SCREWS** save time and money. Here's why: Oily fingers readily grasp the knurled head—the mechanic can drive it a good part of the way by hand before using the wrench. Infinite applications—a wide range of sizes . . .

5 **DANLY KWIK-KLAMP TOGGLE CLAMPS** are versatile, all-around utility clamping tools. Strong construction combined with simplicity of operation makes Kwik-Klamps a must wherever quick, positive clamping action and known pressures are desired . . .



6 **THE DANLY DIE SET** needs no introduction. A *must* for precision stamping, Danly die sets are once more paving the way to that new washing machine and electric iron in every home—that new car in every garage . . .

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Bold Stroke

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★ PIONEERing Better Production Methods and Tools

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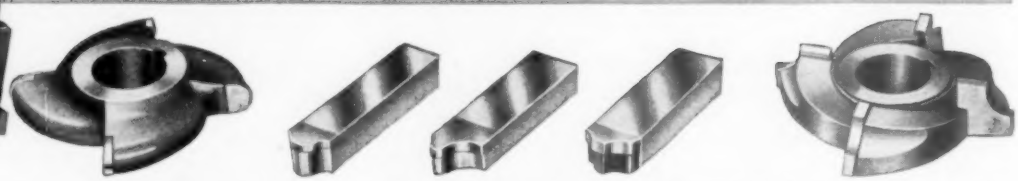
Peacetime Production
MEANS BACK TO COMPETITION!



. . . and here are the tools that will give you the "edge" *on competition* . . .

● Yes, peacetime production will have its problems, even as war production. Not the *same* problems, but just as tough. Competition will require tools that cut clean—fast—smooth—accurately.

You can depend upon MEYERS GENERATED CARBIDE-TIPPED FORM TOOLS to give you the "edge" on competition, by giving you more pieces per hour—more pieces between grinds—and a much smoother finish. On actual production runs, MEYERS GENERATED CARBIDE-TIPPED TOOLS have boosted production by more than 500%!

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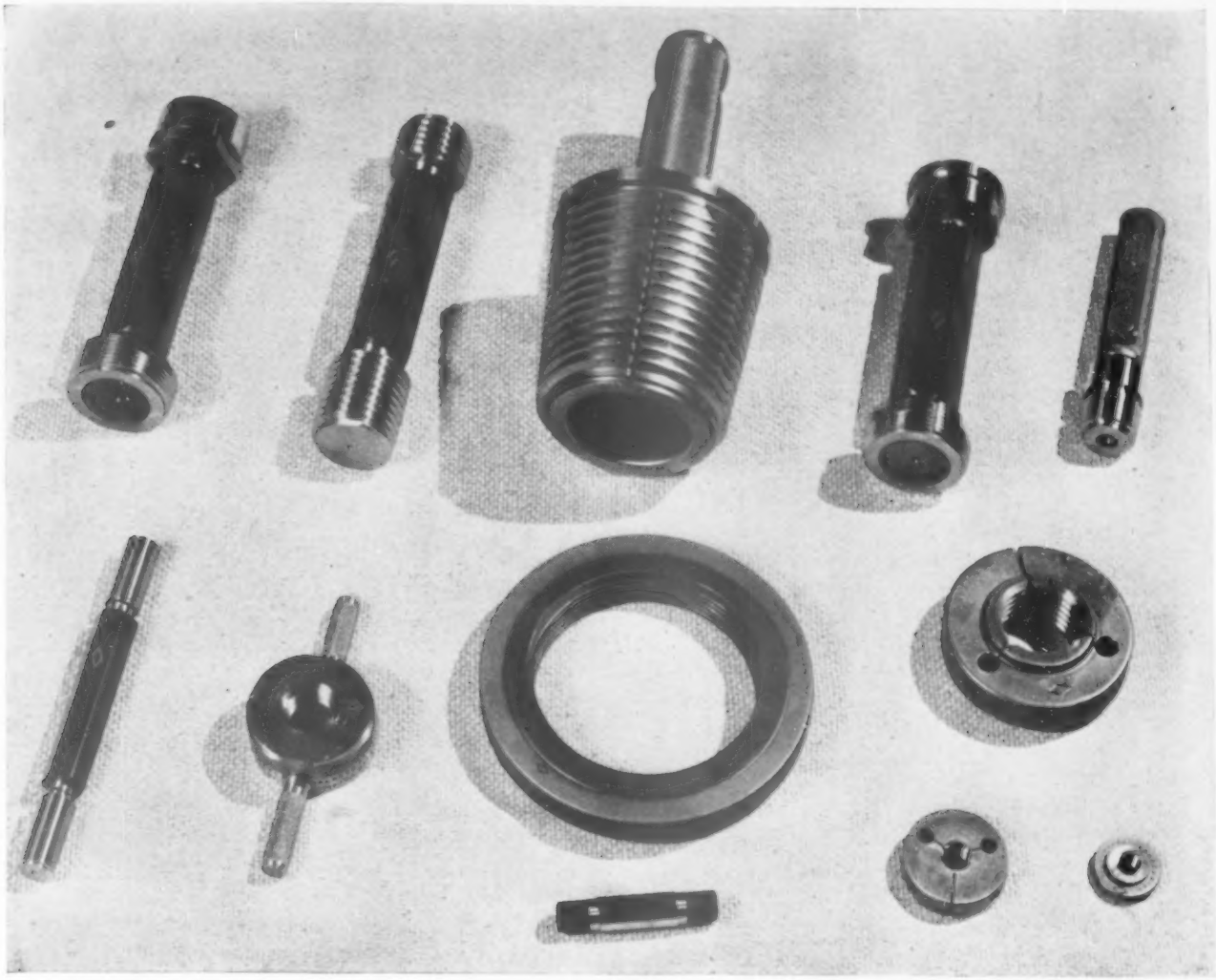

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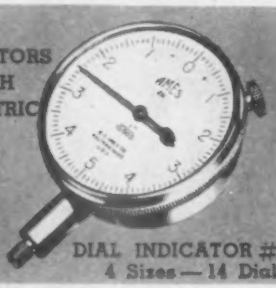

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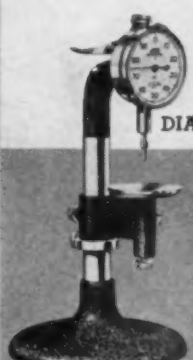
4 Sizes — 14 Dials

DIAL COMPARATOR #26



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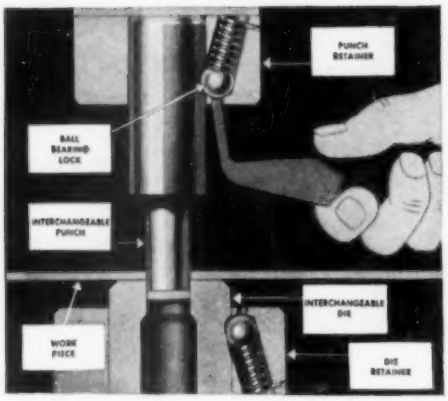

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highest grade tool steels

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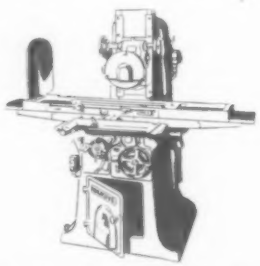


ABRASIVE NO. 3-B AUTOMATIC FEED SURFACE GRINDER
Work Capacity: 24" long x 8" wide x 12" high.
Table size overall: 66" x 10½".
Net weight: 2,700 lbs.
Wheel size: 10" diameter standard—up to 16" for special applications.

Machinists easily meet the pace of heavy production schedules with the ABRASIVE No 3-B—its smooth action and perfect control are a real help in turning out highest quality work. Management, too, finds the ABRASIVE No. 3-B amazingly productive — it's always on the job. In competitive production, the fast, automatic feeds and precision performance of the 3-B pay good dividends. Write for Bulletin.

We will gladly supply information on ABRASIVE Machines on the Government Machine Tool Surplus List . . . just send us the machine serial numbers. Attachments, accessories and repair parts can also be provided.

ABRASIVE MACHINE TOOL CO.
East Providence 14, R. I.

ABRASIVE
ACCURACY BOOSTS PRODUCTION

EXCELLENT CHARACTERISTICS OF SHAVED GEARS *Can be Preserved in Hardening*

Gear tooth hardness need no longer be a compromise between machinability and wear resistance. Red Ring Rotary Gear Shaving as the final machining operation on the green gear, during which approximately .001″ of stock is removed from the tooth surfaces, corrects cutting errors of index, helical angle, tooth profile, eccentricity and undesirable tooth roughness.

This corrected gear may then be induction hardened to whatever surface hardness is desired and without objectionable distortion. Hardening without detrimental distortion is frequently accomplished on gears carburized after shaving by quenching in dies and sometimes by liquid carburizing and quenching without dies. No grinding of tooth profile is necessary.

On a 5.145″ P.D. gear so treated, final involute error is held to between +.00015″ and —.00015″; parallelism to .0002″; tooth spacing to .0001″ to .0002″; and accumulated error to .0008″.

WRITE FOR DESCRIPTIVE FOLDER ON RED RING GEAR SHAVING

Specialists on SPUR AND HELICAL INVOLUTE GEAR PRACTICE

Originators of ROTARY SHAVING AND ELLIPTOID TOOTH FORMS

NATIONAL BROACH AND MACHINE CO.

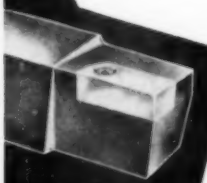
RED RING PRODUCTS

3600 ST. JEAN • DETROIT 13, MICH.

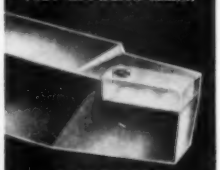
Introducing

KENNAMETAL TOOLS with "Screwed-on" Tips

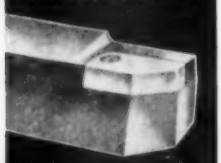
TO HELP YOU CUT TOOLING COSTS ON MANY MACHINING OPERATIONS



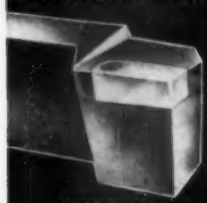
STYLE 6ST (3ST OPPOSITE HAND)



STYLE 12ST (11ST OPPOSITE HAND)



STYLE 40ST (39ST OPPOSITE HAND)



STYLE 2ST (1ST OPPOSITE HAND)

STYLE 10ST (9ST OPPOSITE HAND)

Kennametal tools having tips attached with recessed-head screws—an arrangement developed and perfected by Kennametal Inc.—provide a practical, new way of obtaining even better performance from inherently efficient Kennametal.

The screwed-on assembly is a positive, simplified mechanical fastening of streamlined design. The screw, angularly positioned, serves merely to hold the tip firmly in the shank (heat-treated) against the recess walls, which of themselves resist the main cutting thrusts.

These new tools offer you many advantages, including: Easier, cheaper attachment, in your shop, of tip to tool; greater tip durability and more consistent performance; opportunity to interchange tips quickly in same shank; minimize stock keeping.

Kennametal "Screwed-on" tools are now available in larger sizes of fifteen different styles. Standard tips are made, of different Kennametal compositions, for cutting steel, cast iron, or nonferrous metals. Catalog particulars and prices are yours for the asking.

STYLE 21ST

STYLE 15ST

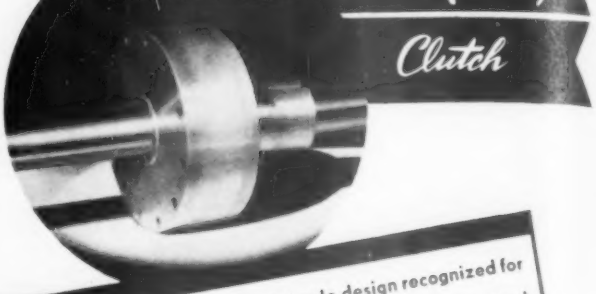
STYLE 5GS (STYLES SJL and SWS ALSO AVAILABLE)

KENNAMETAL

SUPERIOR CEMENTED CARBIDES

KENNAMETAL Inc., LATROBE, PA.

THE HILLIARD *Over-Running Clutch*



A "Free Wheeling" Clutch of simple design recognized for many years as "Standard Equipment" for Automatic Dual Drive operation—Automatic operation of 2 Speed drive—As a ratchet permitting infinite adjustment and as an automatic backstop. Furnished in a number of types.

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ARE YOU OVERLOOKING *Thread Rolling?*

The process that excels in 6 ways!

- √ *Lower Cost*
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ROLLED THREAD DIE COMPANY

Thread Rolling Dies and Machines

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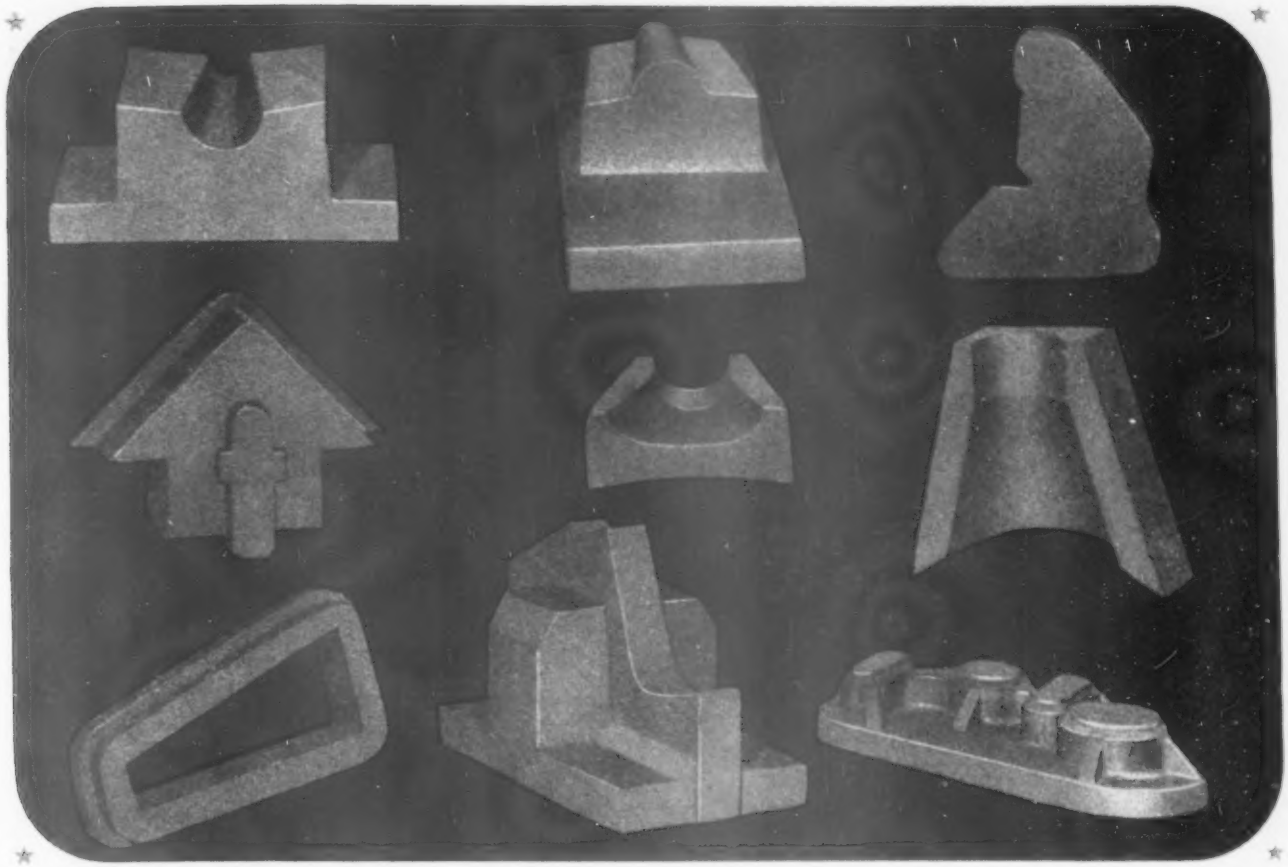

In this method OF TOOL AND DIE MAKING YOU BUY LESS STEEL AND REDUCE MACHINING COSTS

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It gives you details of FCC Air Hardening, Oil Hardening and other Cast-To-Shape Tool Steels and describes other FCC money-saving Tool Steel Specialties.

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FCC Cast-To-Shape, the modern method of tool and die making, is effecting important savings of time, trouble and money for an increasing number of manufacturers.

Even very intricate shapes can now be cast successfully within an eighth inch of finished size. This means that you buy less steel at the start and reduce machining costs substantially.

Tools which could not be made by conventional methods except in sections can often be fabricated from FCC Cast-To-Shape blanks in a single piece.

In many instances performance of the tool is better than can be obtained by fabrication from bar stock or forgings.

Particulars are available through Allegheny Ludlum representatives; or write for the booklet today.

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Forging and Casting Division

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THE LINE THAT STANDS UP

THE BAY STATE LINE

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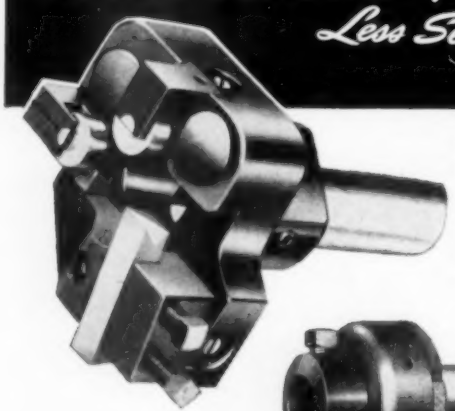
On nearby shelves of industrial supply distributors.

BAY STATE TAP & DIE COMPANY
MANSFIELD, MASS.

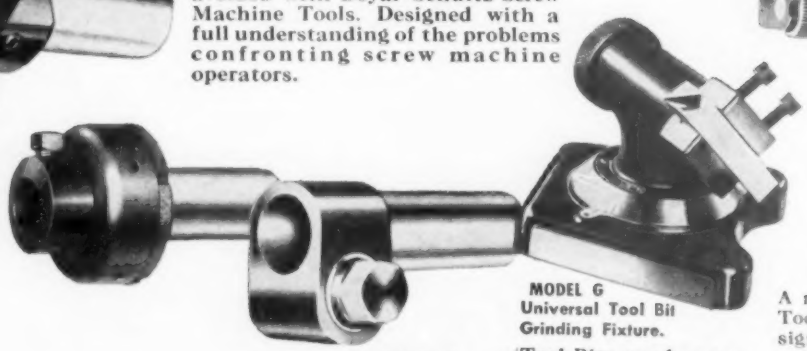
BOYAR-SCHULTZ *Full Time* SCREW MACHINE TOOLS

Less Set-up Time Less Down Time
More Production

Much of the costly delay in setting up screw machine jobs can be avoided with Boyar-Schultz Screw Machine Tools. Designed with a full understanding of the problems confronting screw machine operators.



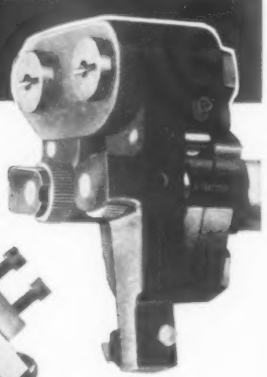
MODEL T Turning Tool.
A new, improved Screw Machine Tool designed with special emphasis on quick accurate set up for precision turning. Less down time is the result of speed in adjustment. Model T Screw Machine Tool is made in five sizes—Nos. 000, 00, 0, 2 and 3.



MODEL D
Floating Tool Holder.
For reaming, counterboring and drilling to close tolerances. In 8 Sizes. No. 000—to No. 6.

MODEL H
Precision Adapter.
A permanent Tool that permits the use of more than one size screw machine tool on a given size screw machine. Made in 6 Sizes.

MODEL G
Universal Tool Bit Grinding Fixture.
Tool Bits can be accurately and uniformly ground with any desired chip clearance angles. Uniformly ground tool bits save time in set-up, save tool steel and save time in grinding.



MODEL K
Knurling Tool.
A new Screw Machine Tool of outstanding design and construction making it possible to perform many of the knurling jobs formerly considered impossible with tools of other types. Speedy in operation, giving clean, accurate knurling in a minimum of time.

Write for complete details on above tools

BOYAR-SCHULTZ CORPORATION—2106 WALNUT STREET, CHICAGO 12, ILL.

Are Production Costs Bothering YOU?

CUT THEM! WITH TECO CEMENTED CARBIDE

Your first cost-cut with TECO Cemented Carbide comes from increased production per man, per machine. TECO produces more pieces between grinds and holds cutting efficiency longer than other carbides—a fact which you can easily prove.*

Your second cost-cut is in reduced down-time, since TECO-equipped machines run for longer periods and are down less often.

Your third cost-cut is in tool cost. TECO Cemented Carbide is more resistant to wear and breakage, thus gives more grinds per tool and a greater productive life. Fewer tools do a bigger job!

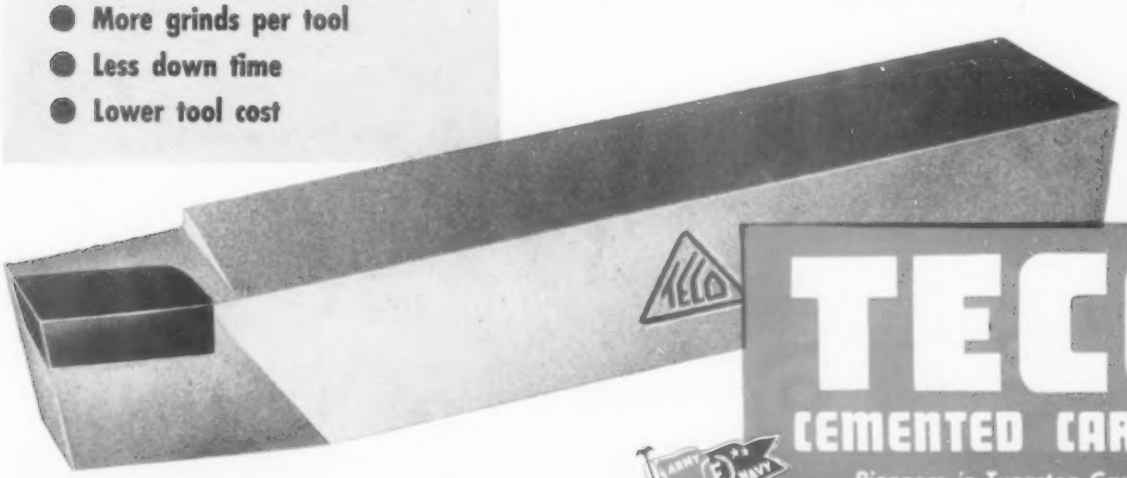
Have one of our tool engineers discuss your needs. Write for catalog and price list.

TUNGSTEN ELECTRIC CORPORATION • 570 39th St., Union City, N. J.

*Prove it this Way!

Tool up a few jobs with TECO Cemented Carbide. Run exactly as with your present tools. Then check the work, pieces between grinds, grinds per tool, total pieces produced. You'll find that you get

- **More pieces between grinds**
- **More grinds per tool**
- **Less down time**
- **Lower tool cost**



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Pioneers in Tungsten Carbides for over a Quarter Century

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That's why we know it gives them what they want—quick, accurate checks of internal diameters—exposing at once any errors of size, taper, bell-mouth or out-of-round condition.

AMERICAN HOLE CHECKERS are easy to set up for Inspection or Production gaging. Accurate to .0001". Dial is read at a glance. Special sizing plugs are made to fit the production part—thus it is easy to adapt the HOLE CHECKER to all types of internal dimensional control.

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HOLE CHECKER

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Thread Checkers
Bench Centers
Radius Dressers
Lapping Plates

THE AMERICAN GAUGE CO.
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DID YOU MISS SEEING THIS AD LAST MONTH?

Well, Here's Another Chance to Read It

Once the present back-log of unfilled orders disappears and we return to a buyer's market, shops with up-to-the-minute equipment will get the business with far less expense than will those still clinging to old-style, worn-out tools. You will have a head start if you will begin by replacing your outmoded solid milling cutters and lathe, planer and shaper tools with O K Inserted-Blade Metal Cutting Tools. In these tools, only the cutting edges are made of the less expensive, but exceedingly strong, alloy steel. The blades or bits that do the cutting may be readily adjusted in line of wear—replaced with others from the tool crib—or shapes may be ground for special jobs. With the O K System, you handle a wider variety of work—get more out of your tools—DO A BETTER JOB!

An O K Milling Cutter for milling locomotive side rods and other heavy duty jobs. One of scores of O K designs of milling cutters.

INSERTED-BLADE METAL CUTTING
TOOL SYSTEM

MANUFACTURED ONLY BY THE O K TOOL COMPANY, SHELTON, CONN., U. S. A.

525 Lap weld seams per HOUR!

"AIRGRIP" Non-Rotating Cylinders on Resistance Welding Machine of the Resistance Welder Corp., Bay City, Mich. Either end of the "AIRGRIP" Non-Rotating cylinder can be removed, leaving rest completely assembled.

By equipping this resistance welding machine with EIGHT*

AIRGRIP

Dual Action

NON-ROTATING CYLINDERS

Production capacity is stepped up, makes lap weld seams on 525 cylindrical containers in one hour!—and quality, uniformity and smoothness of welds are improved. "AIRGRIP" Cylinders do four jobs: (1) They clamp the work. (2) They unclamp it. (3) They lock fixtures. (4) They apply welding pressure.

"AIRGRIP" Cylinders have *no tie-rods.* Ample strength is provided by making the metal of cylinder walls extra thick —⅛ of an inch.

"AIRGRIP" Non-Rotating Cylinders speed production in many ways. Tell us about your machine operations. Our engineers will investigate your requirements, make recommendations.

* On this welding machine the "AIRGRIP" Cylinders operate in pairs because two cylindrical containers are welded simultaneously.

OTHER ANKER-HOLTH COST REDUCERS include "AIRGRIP" Chucks and Rotating Cylinders, Air Operated Collets, Arbors, Mandrels, Drill Press Chucks, 2- and 3-Jaw Finger and Compensating Chucks, Lubricating Assemblies, 3- or 4-way Air Valves (hand or foot operated), etc. Also Hydraulic Power Units and Fittings.

Representatives in all principal cities. Write for Bulletins.

ANKER-HOLTH MFG. COMPANY

2733 Connors Street Port Huron, Michigan

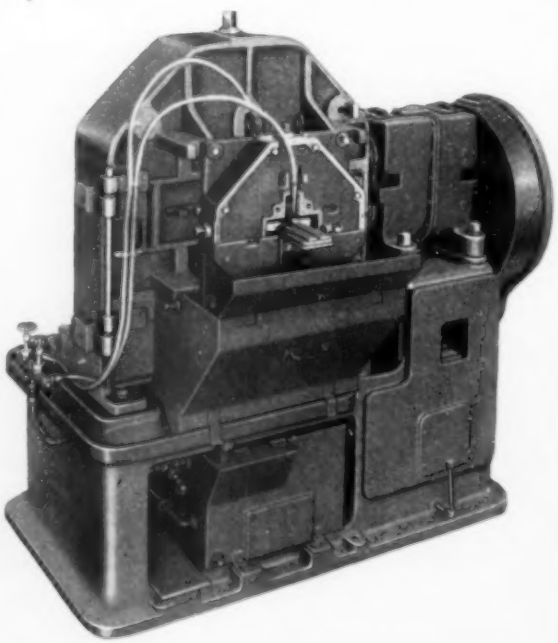
1295

When buying new lathes, specify "AIRGRIP" Chucks and Cylinders

All four sides are rolled simultaneously by "Standard" Turks Heads (adjustable draw plate)—the metal trade's established method of drawing rod to triangular, rectangular and special shapes such as keystone, diamond, star and channel forms—both plain and ornamental.

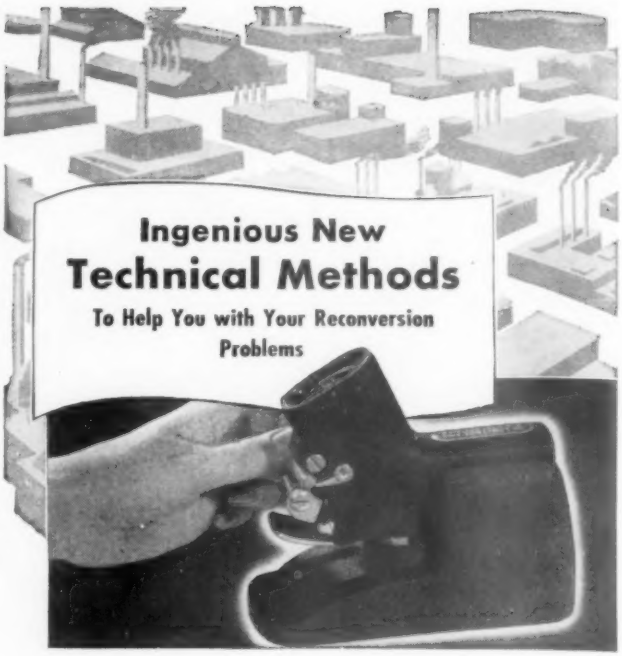
"Standard" Turks Heads, universal and plain types, are available in a wide range of capacities.

Write for Catalog T.H.



STANDARD MACHINERY CO.

1585 ELMWOOD AVE., PROVIDENCE 7, R. I.



New Comparator Gage Saves Time—*Gives 6 Inspections in One!*

Even the most inexperienced operator can obtain accurate inspection of externally threaded parts, with the Limitrol Comparator Gage—in many instances, increasing the rate of inspection as much as 400%! The Limitrol, proved in hundreds of war plants, permits 6 visual checks in one: pitch diameter, lead, taper, out-of-roundness, angle, and straightness. Its use reduces inspection and production costs, cuts scrap waste while increasing speeds of operation. If a part passes the Limitrol, it will assemble accurately.

Hand Model used for "in process" gaging

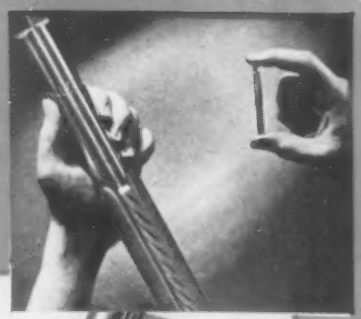
Graduated dials are furnished as standard equipment. These dials are graduated in increments which approximate .0005 inch when the magnification is 250 to 1, and serve as a guide in determining just how far over or under the limits the part might be.

Another "help on the job" is chewing gum. Chewing seems to make work go easier, time go faster. Good chewing gum is available, but there's still a shortage. That's why we at Wrigley wish we could make Wrigley's Spearmint now, to help increase the available supply. You may be sure we will, just as soon as sugar restrictions are lifted. Meanwhile, chew any good available brand, because it's the chewing that **really does you good.**

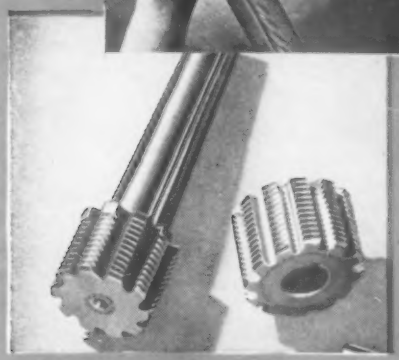
You can get complete information from N. A. Woodworth Co., Sales Division, 1300 E. Nine Mile Road, Detroit 20, Mich.

AA-52

Do it with DALZEN



Left: Dalzen taps, in U. S., Metric, Whitworth, and Special forms are precision ground of hardened high speed steel in a complete size range. TUNGSTEN CARBIDE TAPS — EITHER SOLID OR INSERT — A SPECIALTY.



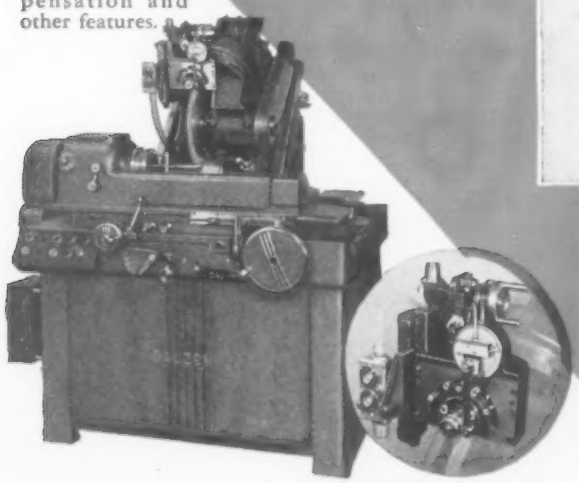
Left: High speed ground thread milling cutters, scientifically heat treated for longer cutting life.

Dalzen manufactures an extensive line of precision cutting tools, parts, thread grinding and special machines — engineered for maximum efficiency and economical operation. Each is the result of years of experience on the part of designers and craftsmen. These are reasons why, all over the United States and in many foreign countries, master mechanics who have used and worked with Dalzen-made machines and tools say, "You can do it better with Dalzen." Write for details on how Dalzen can "do it better" for you.

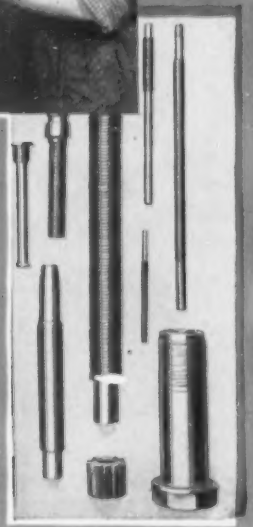
Below: Dalzen "2-in-1" combines a dependable, accurate center lapping machine with a sturdy drill press. Saves on equipment costs, floor space.

Below: No. 5 *Electronic* Thread Grinder. Easy to operate. High production efficiency and accuracy by controlled wheel speed, motor driven dresser, automatic compensation and other features.

Right: No. 2 Thread Grinder. Compact, upright design saves floor space. Simple to operate. Low first and maintenance cost. Ideal for short or production runs.



Right: Threaded parts are ground to close tolerances exactly to your specifications. Rigid inspection standards assure a uniform fine finish. Jobs requiring rolled or cut threads are also handled.



DALZEN

TOOL AND MANUFACTURING CO.

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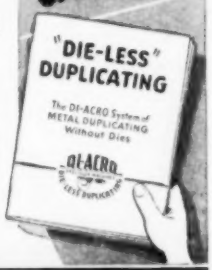
"DIE-LESS" DUPLICATING

SAVES MAN HOURS AND DELAYS

DIE ACCURACY WITHOUT DIES

Send for CATALOG

DI-ACRO is pronounced "DIE-ACK-RO"

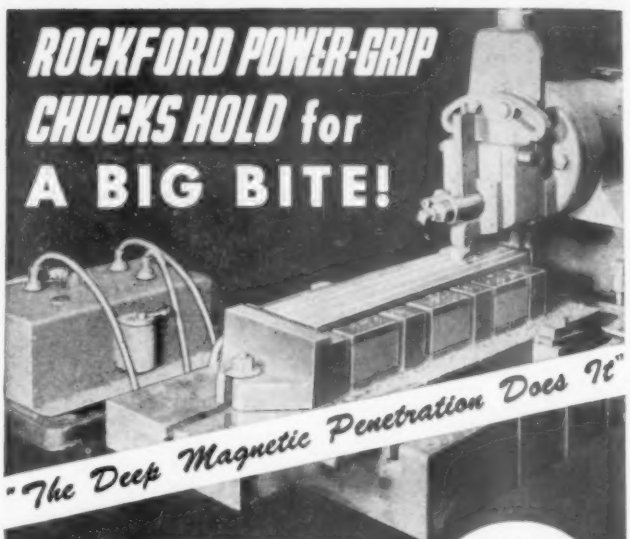


DI-ACRO PRECISION MACHINES DIE-LESS DUPLICATING

O'NEIL-IRWIN MFG. CO.

375 EIGHTH AVE. SOUTH, MINNEAPOLIS 15, MINN.

ROCKFORD POWER-GRIP CHUCKS HOLD for A BIG BITE!



"The Deep Magnetic Penetration Does It"

The magnetic circuit in Rockford Power-Grip Chucks penetrates chuck and work, locking them together in a power grip that holds for heavy cuts on milling machine, shaper or planer.

Knotty Holding Jobs Simplified
Costly Time Lags Eliminated

ROCKFORD MAGNETIC PRODUCTS COMPANY
1304-18th Ave., Rockford, Ill.

WRITE FOR THE POWER-GRIP BOOK

THESE GAGES SAVE 3 WAYS!

1 *Extra length* — Cut off leading ends as they become worn.

2 *Reversible*—Both "Go and No-go" plugs can be turned end for end when worn. Thread gages are also reversible.

3 *Chrome Plated* — Superfinished chrome plate greatly increases service life of gages. Gages with Stellite and Carboloy plugs and sapphire tipped plugs also available.

Trade-in Allowance on your worn gages! Send for details.

SIZE CONTROL COMPANY

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DIVISION OF
AMERICAN MACHINE & GAGE COMPANY
SIZE CONTROL CO. Precision Gages · WALSH PRESS AND DIE CO. Punch Presses · WACKER SALES DIVISION Precision Inspection Equipment
Engineering Representatives in Principal Cities

Columbia TOOL STEEL

PEACE and PLENTY
Better than ever Columbia Tool Steels are in stock ready to work for peace and plenty
It pays to use Good Tool Steel.

COLUMBIA TOOL STEEL COMPANY
ARTHUR T. CLARAGE, PRESIDENT
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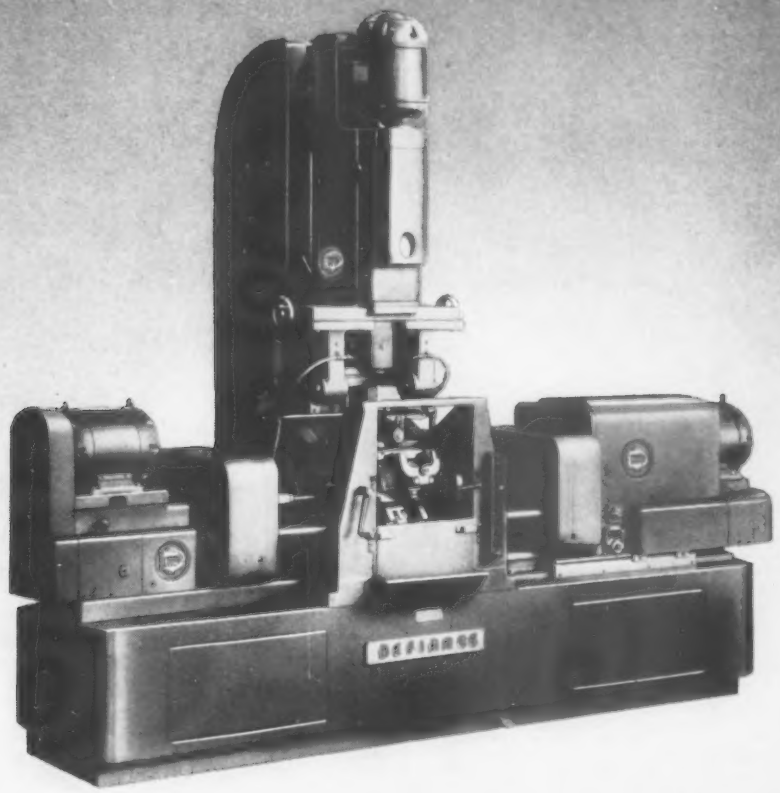
520 EAST 14TH. STREET • CHICAGO HEIGHTS, ILL.

HIGH PRODUCTION DRILL



● This three-way machine with five station indexing fixture shows the adaptability of Defiance Production Drilling Units to a production machine. These newly developed, greatly improved Defiance Cam and Hydraulic Units are available with standardized base and column design—for either horizontal or vertical mounting. Bases and columns are of welded steel to the dimensions required by the individual job . . . fixtures also specially designed for each job.

More and more shop men have learned through experience that Defiance-built Machines are "tops" in dependability, long life, and low-cost maintenance. Write for catalog.

Defiance Machine Works, Inc., Defiance, Ohio.

ARMY NAVY

DEFIANCE

BUILDERS OF PRECISION MACHINERY SINCE 1850

ENGINEERS—PRODUCTION—INSPECTION MEN!

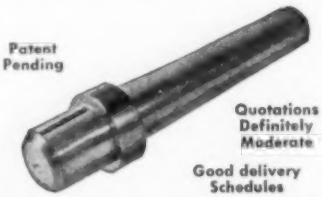
**BOOST PRODUCTION AND PRODUCT QUALITY—
15 DAY SHIPMENT OF URGENT ORDERS**

Curtiss-Wright Corporation ranks our product with *their* best tools. Cleveland Graphite Bronze Company, leading bearing manufacturer, states new high accuracy reached, plus substantial production boosts.

No more "C" washers, wrenches, drawbars, no more arcs or tapers before or after expansion grip—concentricity in low 10,000ths — production or inspection.

Assured parallelism of sleeve surface to center line—absolutely no variation in repeated mounting of parts. Uniform full-work-length friction-locking gives complete control and contact of entire bore surface area —Absolutely .no variation in repeated mounting of parts—no tapers—Slip part on mandrel with slight counter-clockwise motion, that's all—it's ready—Self-contained, self-expansion, self-locking, self-contraction. Instant unloading, no jamming, no adjusting —Interchangeable sleeves—you do not obsolete Young Mandrels.—Built to your bore tolerance high limit, with automatic contraction to low limit—Any mounting—Any machine operation—For bore diameters .718 to 5.5—Reduces tool costs, extra equipment investment, operating costs, maintenance, down time, scrap, salvage.

Young Roller Clutch Precision Mandrels



Patent Pending

Quotations Definitely Moderate

Good delivery Schedules

YOUNG ARBOR CO., 3257 Bradford Rd.

CLEVELAND HEIGHTS 18, OHIO

FOR THAT *Tough* TAPPING OR REAMING JOB!

WHEN things go wrong on some particular tapping or reaming operation, and work keeps coming through with oversize or bell-mouthed holes, don't be licked! The main trouble probably lies in the tool holder you are using. Unless it compensates for inaccuracies in set-up as the Ziegler Holder does, faulty work is bound to be the result.

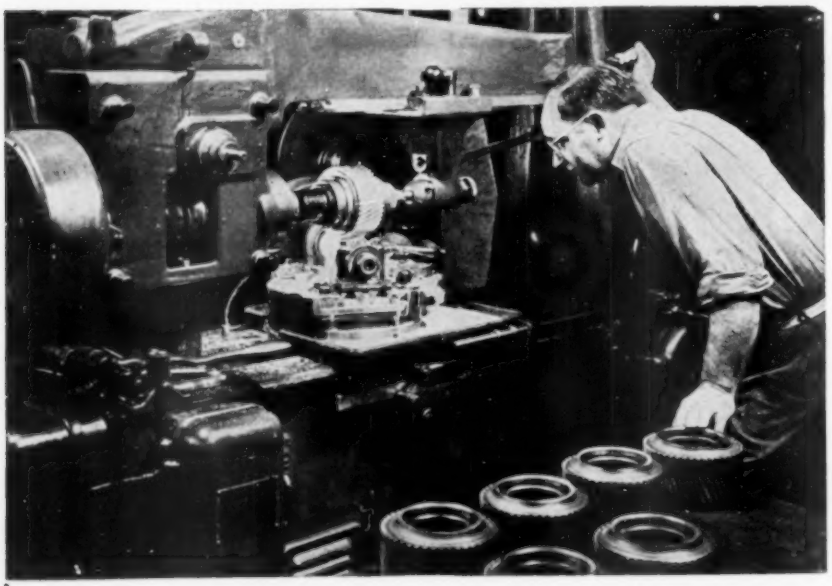
So, if you have a particularly tough job, change over to the Ziegler Floating Holder. You'll be surprised at how it will smooth out your difficulties.

W. M. ZIEGLER TOOL CO.

1930 TWELFTH STREET **DETROIT 16, MICH.**

WRITE FOR CATALOG

***Ziegler* ROLLER DRIVE FLOATING HOLDER *for* Taps *and* Reamers...**



National-Cleveland High Speed Hob cutting driving gear at Cletrac Plant

From Blueprint to Product

In the manufacture of tractors at the Cletrac Plant of The Oliver Corporation in Cleveland precision manufacturing is of vital importance. On this machine in the Cletrac Plant the transmission fourth-speed driving gear is hobbed. This 43 tooth gear of 7/9 pitch is made of 4620 S.A.E. steel forging with the helix angle L.H. 23° 12′ 57″ and both the tooth spacing and helix angle are held to a tolerance of .0003 and the runout to .0005.

To obtain precision parts, precision tools are required. We are proud to be the manufacturer of much of the cutting tool equipment used by Cletrac.

NATIONAL TOOL PRODUCTS

**BROACHES • HERRINGBONE CUTTERS
SLITTING SAWS • COUNTERBORES
REAMERS • GEAR SHAPER CUTTERS
GEAR CUTTERS • MILLING CUTTERS
CIRCULAR AND FLAT FORM TOOLS
HOBS, GROUND AND UNGROUND**

National Tools are the Shapers of Progress

NATIONAL TOOL *Co.*

11200 MADISON AVENUE CLEVELAND, OHIO

THE BIG THREE

★ **THE BIG THREE** amount to a policy which we have maintained throughout 16 years of designing and building tools for industry.

If you are interested in tools that measure up to these standards, we will be glad to receive your inquiry.

QUALITY TOOL & DIE CO.

Manufacturers of "Quality" Products

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Again! **PARKER-MAJESTIC**

Leads **WITH NEW TIME SAVING FEATURES**
(PAT. PENDING)

No. 2 SURFACE GRINDER

Adaptable to all precision tool room jobs • 7 spindle speeds from 2000 to 6000 RPM • quick and positive crossfeed saddle locking, for spline or form grinding, without saddle distortion • grinds work to 18" long, 6" wide, and 9½" high, using a wheel 7" in diameter.

A Wise Buy For a Careful Buyer

Send for Descriptive Circular

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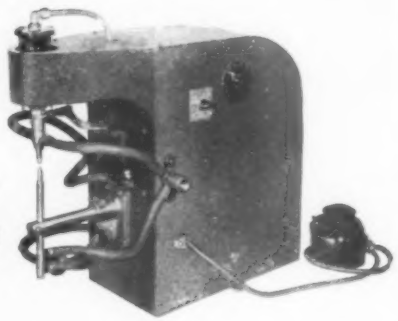
187 JOS. CAMPAU DETROIT 7, MICHIGAN

MODEL No. 263-A
WELDEX ELECTRONICALLY TIMED SPOT WELDER

3 K. V. A.
220 Volts
60 Cycle
Single Phase
Air Operated
Bench Type



- Solenoid Air-Valve Foot-Switch Operated
- Built-in Electronic Timer
- Adjustable Pressure Switch

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WELDEX INCORPORATED • 7338 McDonald Ave.
Detroit 10, Mich.

INSURANCE POLICY *for production*

SUGGESTIONS FOR THE APPLICATION OF
Stuart's ThredKut

Per Cent of ThredKut Suggested	CHARACTERISTICS OF OPERATION AND MATERIAL — EACH COLUMN IS IN REFERENCE TO COLUMN ONE ONLY, NOT TO ANY OTHER. WHEN TWO RECOMMENDATIONS CONFLICT, TRY THE MEAN BETWEEN THE TWO								
	Hardness of Material	Carbon Content of Steel	Cutting Surface Speed	Depth of Cut	TROUBLE		TOOL		MATERIAL	
							General	Screw Mach.		
Very Low	Very Hard	Very High	Very Fast	Very Light	Rough Finish or Tool Scuffing	DECREASE THRED KUT	Milling	Sizing Box	AMS 6440	Brass †Aluminum SAE X1112 SAE 1112
Low	Hard	High	Fast	Light			Boring Turning	Skiving Reamer	NE 52100A NE 9442	SAE 52100 SAE 5140
Medium	Medium	Medium	Normal	Medium	INCREASE THRED KUT		Shaping Hobbing Generating	Form Drill Cut-Off	NE 8630 NE 8620 NE 9420	SAE 3140 SAE 6140 SAE 4140 SAE 4340 SAE 4640 SAE 5120 SAE 3120 SAE 6120 SAE 4130 SAE 2345
High	Soft	Low	Slow	Heavy		Tool wear on Front Clearance or Short Tool Life, (Due to Wear on Front Clearance.)			AMS 6240B AMS 6250B	SAE 4615 SAE 1020 SAE 2320 SAE 2520
Straight	Very Soft	Very Low	Very Slow	Very Heavy			†Broaching †Drawing	Dies †Taps		Copper 18-8 Monel

† Sometimes with SUPERKOOL Base added. ‡ With kerosene or other very light oil.

Copyright 1940, D. A. Stuart Oil Co., Ltd.

Stuart's ThredKut Heavy Duty Cutting Oil has played an important part in solving many of industry's toughest metal working problems. Reference to the time-tested ThredKut Chart* has insured the proper application of this versatile product in many production emergencies. Alert production executives will find these aids of great help in answering troublesome metal-working problems. D. A. Stuart Oil Co., Ltd., 2727-49 So. Troy Street, Chicago 23, Illinois.

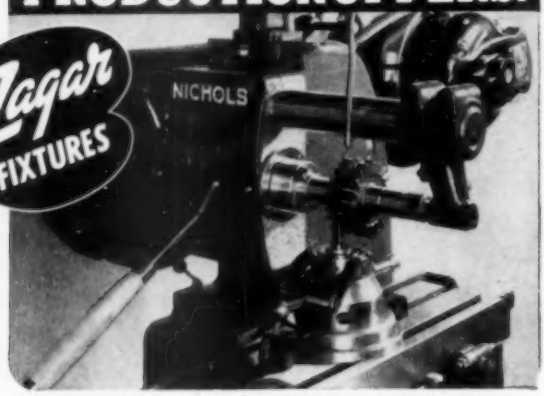
** If you haven't a copy of the Thred-Kut Chart, write us — we will gladly send you one without obligation.*

D. A. Stuart Oil CO.
LIMITED
ESTABLISHED 1865
Stocks in Principal Metal-Working Centers

NEW!
ACTUAL SIZE!
Pneumatic
SCREW DRIVER
by
ARO
First and Only
POWER SCREW DRIVER SPECIFICALLY BUILT FOR SMALL SCREWS!
● Amazingly small in size—this new ARO Screw Driver is only the size and shape of the average cigar . . . weighs but 8 ounces . . . is 4 7/8" long and 3/4" in diameter. Simple to operate—drives screws from No. 1 to No. 6 . . . with fully automatic operation! Pneumatic powered. No manual throttle control . . . starts automatically when tool is applied to work. It adjusts itself to every driving condition.
Also available with adapter socket for nut setting. Simple construction for long life and fool-proof operation. Entire tool is chrome finished. Ideal to *speed up assembly* of radios, cameras, electrical appliances, electronic instruments and controls, and many other products having small screws and nuts. Write today for more information. The Aro Equipment Corporation, Bryan, Ohio.

PRODUCTIONUPPERS!

Zagar FIXTURES



The Nichols Miller now uses Zagar Fixtures as standard equipment.

Zagar Index Fixture • **Zagar Short Fixture**
Zagar Speed Chuck • **Zagar V-H Fixture**
Zagar Air-O Fixture • **Zagar Collets**

See if Zagar hasn't the solution to your collet-holding problem. Also, we have the fixtures in stock to make our counsel good without delay.

Get our growing Catalog "T-1"

ZAGAR TOOL, INC.
23890 Lakeland Blvd., Cleveland 17, Ohio

ZAGAR COLLET TOOLS — **Zagar INDEXING AND HOLDING FIXTURES**

Send for

The facts outlined in this booklet are taken from hundreds of actual cases showing the surprising variety of tools which can be improved by modern treatments. Among the several processes mentioned are:

"SILVER FINISH"—which is clean, bright hardening . . . no oxidization or scale.

"NUSITE"—starts with soft high-speed steel and means harder, tougher cutting tools.

"AD-LIFE"—a combination of supplementary treatments to improve hardened finished tools . . . even new ones . . . no re-hardening is required . . . no danger of fracture or distortion.

What manufacturers of tools, airplanes, trucks, gears, steel molds, food machinery, electrical devices, and many other fields did to improve tool quality and life is told in this valuable booklet.

BETTER HARDENING — BETTER RESULTS

PERFECTION
TOOL & METAL HEAT TREATING CO.
1740-58 WEST HUBBARD STREET CHICAGO 22, ILL.

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DEPENDABLE ACCURACY

The MARVECO Live Center is specifically designed to give you longer service and dependable accuracy in all operations calling for close tolerance precision centering.

The MARVECO is GUARANTEED to OUTPERFORM and OUTLAST any other LIVE CENTER.

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CENTER PROBLEMS

MARVEL TOOL & MACHINE CO.

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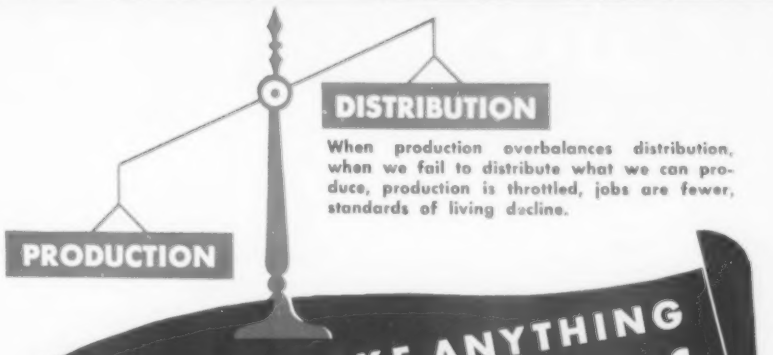

DISTRIBUTION
When production overbalances distribution, when we fail to distribute what we can produce, production is throttled, jobs are fewer, standards of living decline.
PRODUCTION

WE CAN MAKE ANYTHING ...We Must Sell All of Everything We Make

For a long time we in America have derived great comfort and assurance from the knowledge that we have the industrial ability to produce anything we may need or want. We have tied our wagon to the bright star of producing more products at higher wages to sell at lower prices.

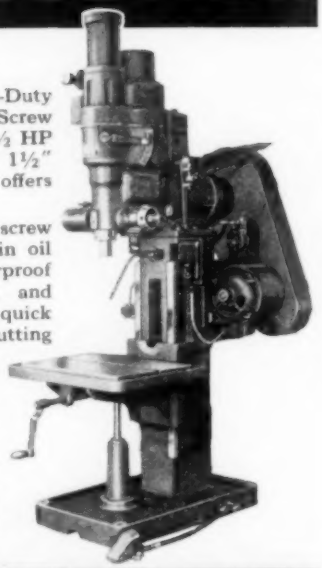
This concept of production has brought us the largest expansion in a standard of living of any people in history.

But, while we have always been able to make anything, we have not always been able to sell all of everything we could make. We have not devoted the same enterprising energy to expanding distribution that we have to production. So, in the past, for immediate short swing relief we have resorted to government imposed restrictions on production and distribution. This expedient did not bring worth-while relief, for in the end it added up to fewer jobs, less production—higher prices.

If commerce and industry will use its inspirational ability and ingenuity to find better, cheaper methods of distribution per unit our goal of full employment may easily be accomplished and we can return to the enviable position of enjoying an expanding standard of living.

MICROMATIC HONE CORPORATION
DETROIT 4, MICHIGAN

FOR CONTINUOUS HIGH DUTY PRODUCTION



KAUFMAN No. 10A Hi-Duty single spindle. Lead Screw Tapper made in 3 HP and 1½ HP models, with ¾" N.C. and 1½" N.C. Threads in alloy steel offers these features:

Fully enclosed . . . lead screw and nut operate constantly in oil bath . . . positively wearproof clutches instantly engaged and controlled by air cylinder . . . quick traverse when not actually cutting threads . . . accurate depth control . . . control to protect tap overload, and further protected against jamming if work is placed in upside down . . . class 3 fits always assured and perfectly controllable. Complete information upon request.

KAUFMAN MFG. CO.
MANITOWOC, WISCONSIN

M·B MODEL UTR 60,000 RPM

"UTILITY" Pneumatic
GRINDER

A powerful, fast-cutting tool, streamlined in design, easy to handle. Designed for real production work and the toughest jobs. Precision made, excellent balance. Special grease-sealed bearings . . . no lubrication required. Fitted with steel housing, a special safety feature.

•

Write for Circular

M·B PRODUCTS
130-134 E. Larned St.
Detroit 26, Michigan

Ample Speed . . . Powerful, Smooth in Operation

•

Also Other Models

•

Air-Line Filters and Automatic Air-Line Lubricators

Extremely Pertinent!

If you have not read the brief report of Mr. J. R. Townsend, President of the American Society for Testing Materials, concerning the great difference he observed in German as compared to American manufacturing methods, you should read it. You will find it on Pages 44 and 45 of the October 1945 issue of the A.S.T.M. Bulletin.

By permission of that Society, we reproduce below most of one paragraph:

> "The trend in American manufacture is toward the use of greater power, more automatic machinery, and a greater degree of mechanization of manufacture. This requires the production of an abundance of material of uniform dimensions and quality to be fed to this automatic machinery. It is only with such material that the automatic machines can work unattended and produce myriads of parts of identical form and quality. To control the uniformity of the raw material it is necessary to develop methods of test. It is also necessary to develop and adopt methods of inspection and quality control. The core of the matter is the development of tests that can be used to measure and indicate variability in quality. This has been the primary concern of A.S.T.M. and our principal contribution to the war effort has been the preparation of such tests and the embodiment of them with proper tolerances into specifications. The use of quantity production and quality control of materials has resulted in the production of an overwhelming amount of weapons that could be used in the war."

Competition with Germany in armaments ceased when the war ended, but competition between American firms is starting now. Those firms who follow most closely the successful American manufacturing methods are sure to win in peacetime competition.

ACCO
An Associate Company of American Chain & Cable

WILSON
MECHANICAL INSTRUMENT CO. INC.
Sole Makers of "ROCKWELL" Tester
373 Concord Avenue, New York 54

NEW MULTI-PURPOSE IDEAL SPEED LATHE

For Polishing, De-burring, Filing, and General Finishing Operations on Small Metal and Plastic Parts.

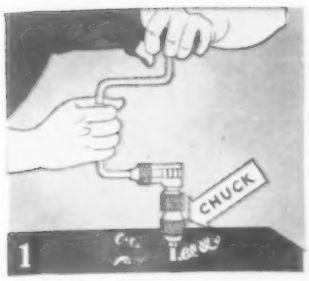
Here is a small, light-duty Speed Lathe · Compact · Complete · Ready to Operate · With All the high-quality construction of the famous larger Ideal Speed Lathes, Plus New and Exclusive Time and Labor Saving Features.

New engineering refinements and improvements provide new ease of operation, greater convenience of operation, and choice of operating sequence through simple, accessible adjustments.

FOR COMPLETE DESCRIPTION WRITE FOR CIRCULAR 453

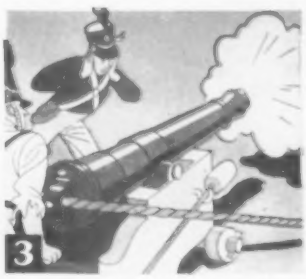
SCHAUER MACHINE COMPANY
ORIGINATORS OF TODAY'S SPEED LATHES
2066 READING ROAD · CINCINNATI 2, OHIO

First you've gotta know what a chuck is

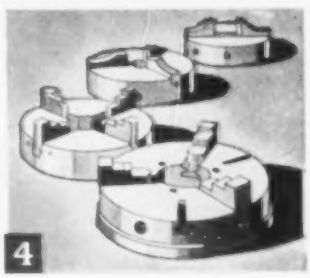


Chucks hold tools or work that are in motion.

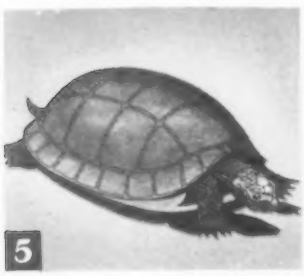
Chucks owe their origin to the ancient potter's wheel.



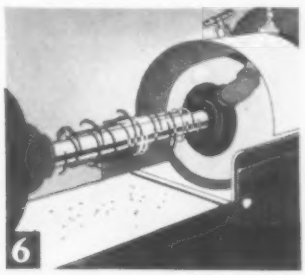
First chucks were used for making cannon in War of 1812.



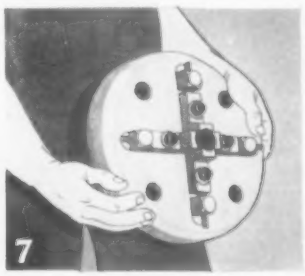
There are many kinds of chucks. Here are some in common use.



Many chucks are too "slow" for modern high-speed production.

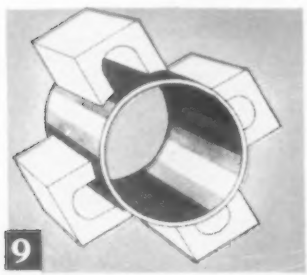


Other chucks aren't positively true —lack hair-splitting accuracy.

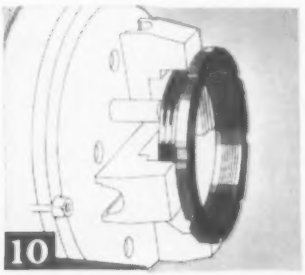


New and better is the amazing Woodworth Diaphragm Chuck.

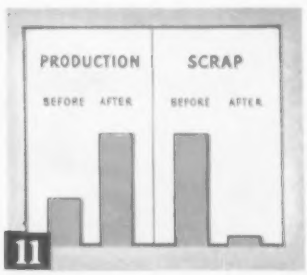
Jaws fasten to diaphragm which flexes like bottom of oil can.



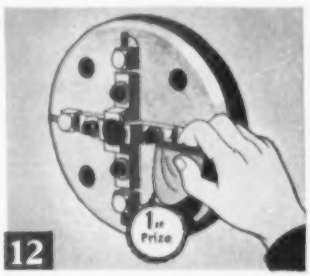
Thin-walled parts won't distort in machining to close accuracy.



Large, heavy parts can be processed with fine precision.



Steps up production 2¼ times—scrap practically eliminated!



A winner! Industry acclaims Woodworth Diaphragm Chuck!

What Woodworth Products Mean to Industry

THE DIAPHRAGM chuck is a typical Woodworth contribution to mass production efficiency. Here's why.

Every Woodworth product must conform to the basic policy of this company—*TO MAKE ONLY PRODUCTS WHICH WILL BENEFIT INDUSTRY THROUGH INCREASED PRODUCTION AND REDUCED COSTS.*

This means that the great demand for Woodworth Tools and Gages will be continuing, especially in view of the coming battle for postwar markets.

And it means that Woodworth engineers have been charged with the responsibility of searching constantly for new ways to speed up and lower the cost of production, in connection with Woodworth Products of the future.

The constant growth and expansion of the N. A. Woodworth Company is due to strict adherence to these objectives.

ACCURACY YOU W CAN TRUST

WOODWORTH

N. A. WOODWORTH CO., SALES DIVISION, 1300 E. NINE MILE ROAD, DETROIT 20, MICHIGAN

PRECISION GAGES

PRECISION MACHINED PARTS

PRECISION TOOLS

EDWARD
Blake
COMPANY
634 COMMONWEALTH AVE., NEWTON CENTRE 59, MASS.

For greater tap LIFE
UNIFORMITY
ACCURACY
Keep 'em sharp on a
BLAKE
TAP GRINDER

No machine is better than the cutting edge of the tool it uses.

Please send me Bulletin 544 which gives complete details on Blake Tap Grinders. T.E.

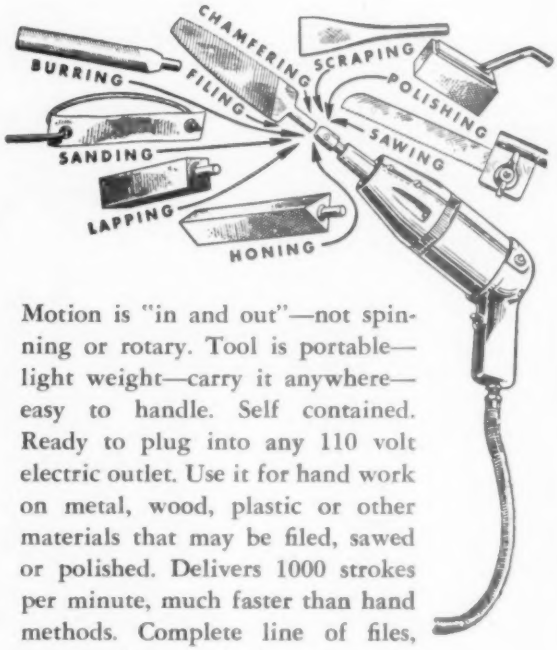
NAME _____ TITLE _____
COMPANY _____
STREET _____
CITY _____ STATE _____

BLAKE TAP GRINDERS—FILTAIRE PORTABLE DUST COLLECTORS—
AMERICAN TOOL HOLDERS—BLACK DIAMOND PRECISION
DRILL GRINDERS—WALTHAM CUTTER SHARPENERS—
HAGER CARBIDE TOOL GRINDERS

For SPEED
and
Performance!

RECIPROCATING ACTION
(In and Out)

PORTABLE
Electric
H & H TOOL



Motion is "in and out"—not spinning or rotary. Tool is portable—light weight—carry it anywhere—easy to handle. Self contained. Ready to plug into any 110 volt electric outlet. Use it for hand work on metal, wood, plastic or other materials that may be filed, sawed or polished. Delivers 1000 strokes per minute, much faster than hand methods. Complete line of files, scrapers, hones and other accessories available.

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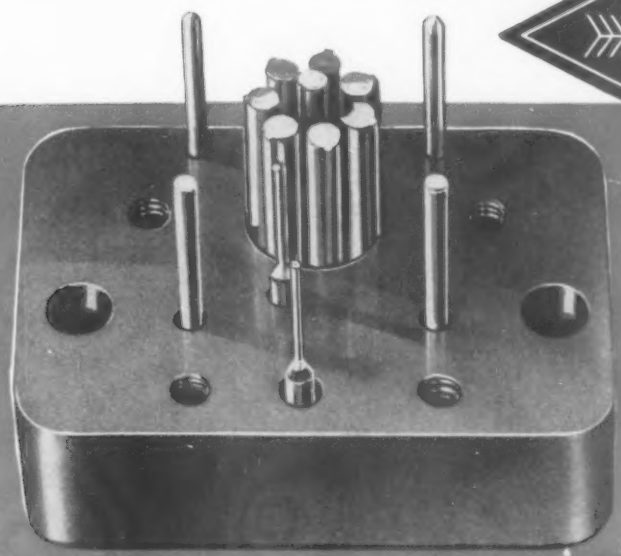
200 CHURCH ST. • NEW YORK 13, N. Y.
Mfd. by H & H RESEARCH CO.

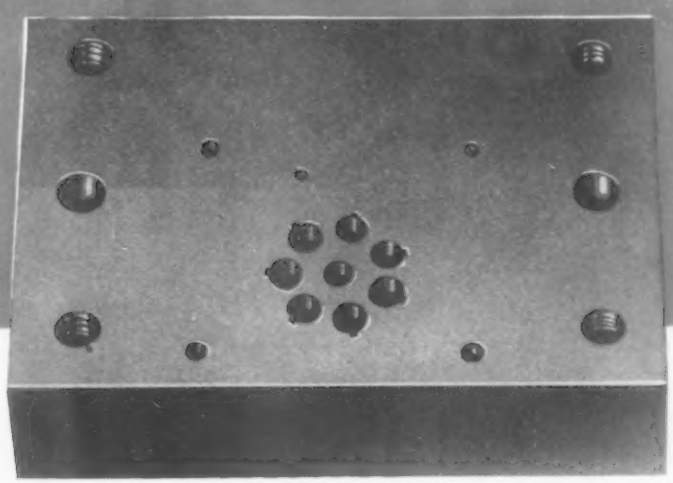
Today's keynote—

PRODUCTION ECONOMY

Today's answer—

INVARO





These Invaro oil-hardening steel blanking dies are meeting a difficult requirement of close tolerance—held to .003 after heat treating . . . no tendency to shrink, warp or change dimensions. Uniform hardness and long life mean high production at low cost.

Look into Invaro for operations such as blanking, punching, forming, piercing, perforating, etc.

If YOU have a die steel problem . . .

Call Firth-Sterling STEEL COMPANY

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Ruthman Patented features

legitimately obtained only

in

RUTHMAN

GUSHER

COOLANT PUMPS

When you purchase or specify Ruthman Pumps for your machines you are assured of pumps with Ruthman owned exclusive patented advantages.

So why accept a copy or substitute?

WRITE FOR OUR NEW HANDY REFERENCE CONDENSED CATALOG.

THE RUTHMAN MACHINERY CO.
1810 READING ROAD
CINCINNATI 2, OHIO
The "GUSHER"—A Modern Pump For Modern Machine Tools

★ ★ ★

YOU FURNISH THE **BRAIN** . . . THE **BRAWN** IS PROVIDED BY

PORTELVATOR

(Portable Elevating Table)

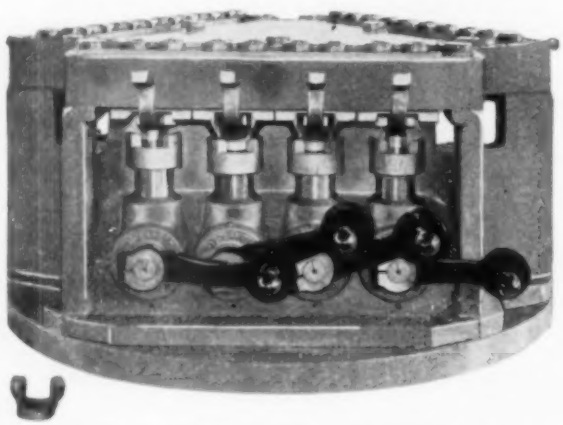
★ ★ ★

WRITE FOR BULLETIN TO DEPT. 24

★ ★ ★

"Not a shop accessory, but a shop necessity" for elevating or lowering; as support; as a level under overhanging work; for carrying almost anything, anywhere, anytime.

THE HAMILTON TOOL CO.
Ninth and Hanover Streets.
HAMILTON OHIO



THREE STATION INDEX FIXTURE FOR DRILLING HOLES IN UNIVERSAL JOINT YOKE. PARTS ARE CLAMPED AGAINST TOP PLATE IN ORDER TO CONTROL THE DEPTH OF MACHINED HOLES.

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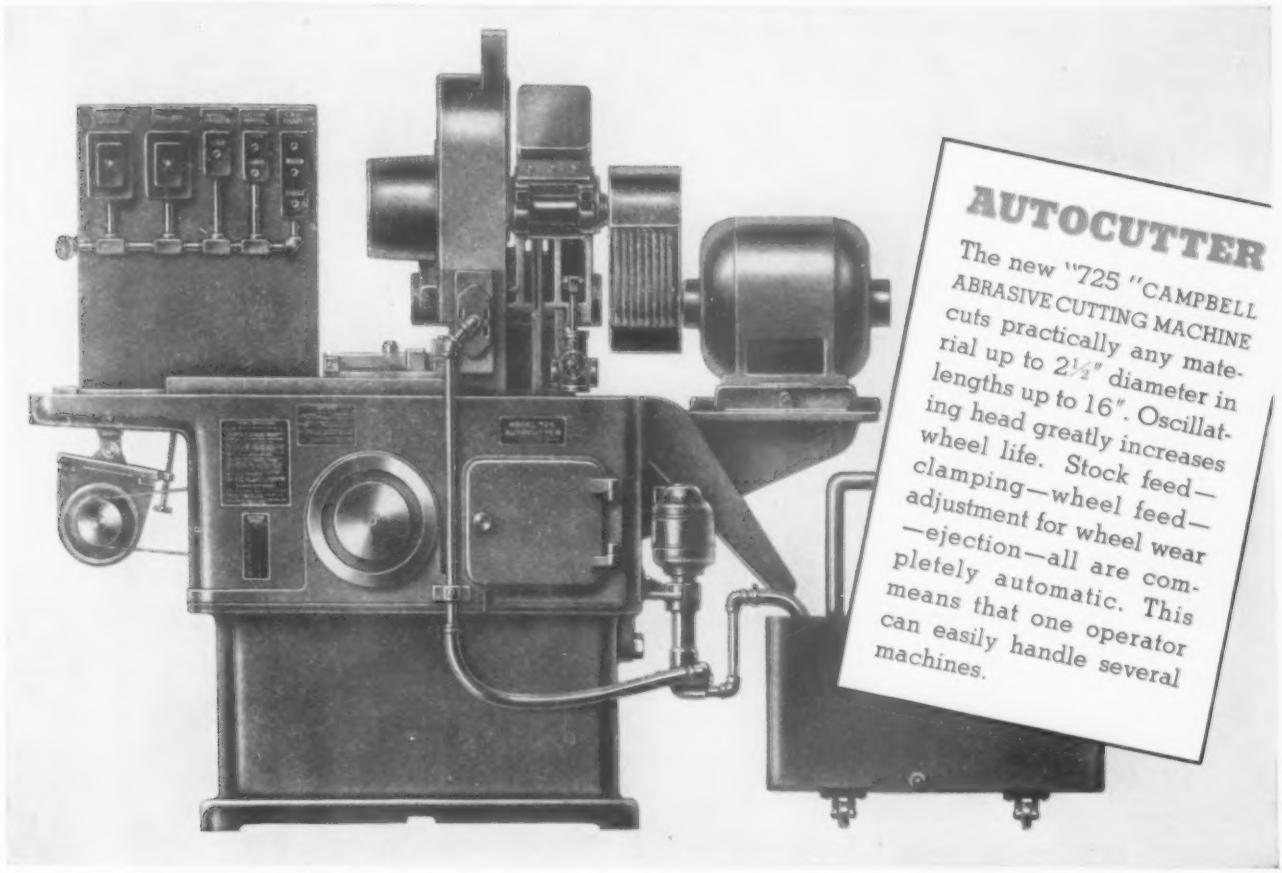

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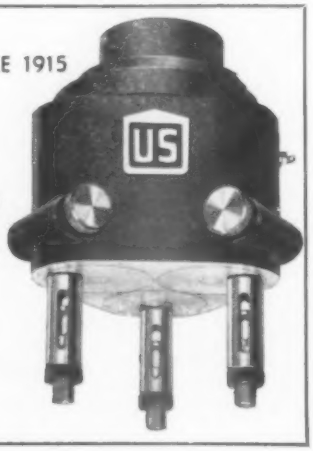

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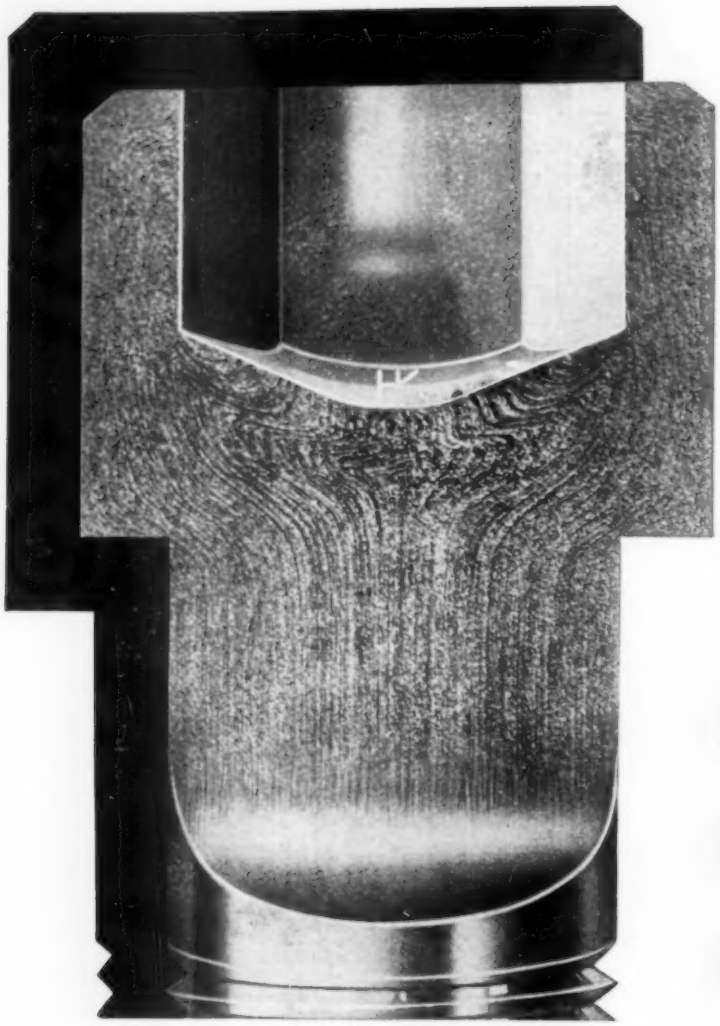

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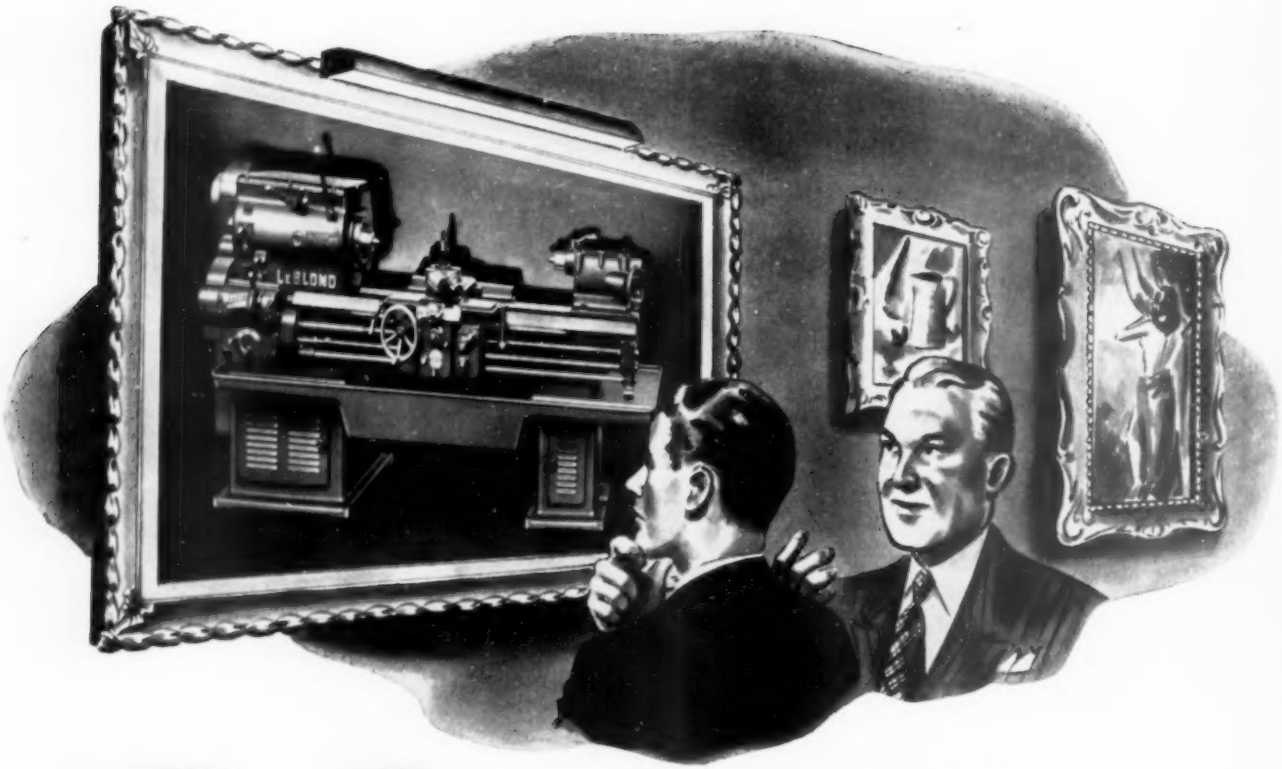

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